AIRCRAFT AND MISSILES

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DESIGN
DEVELOPMENT
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16.4# 128#
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5# 2.8# 39.2#
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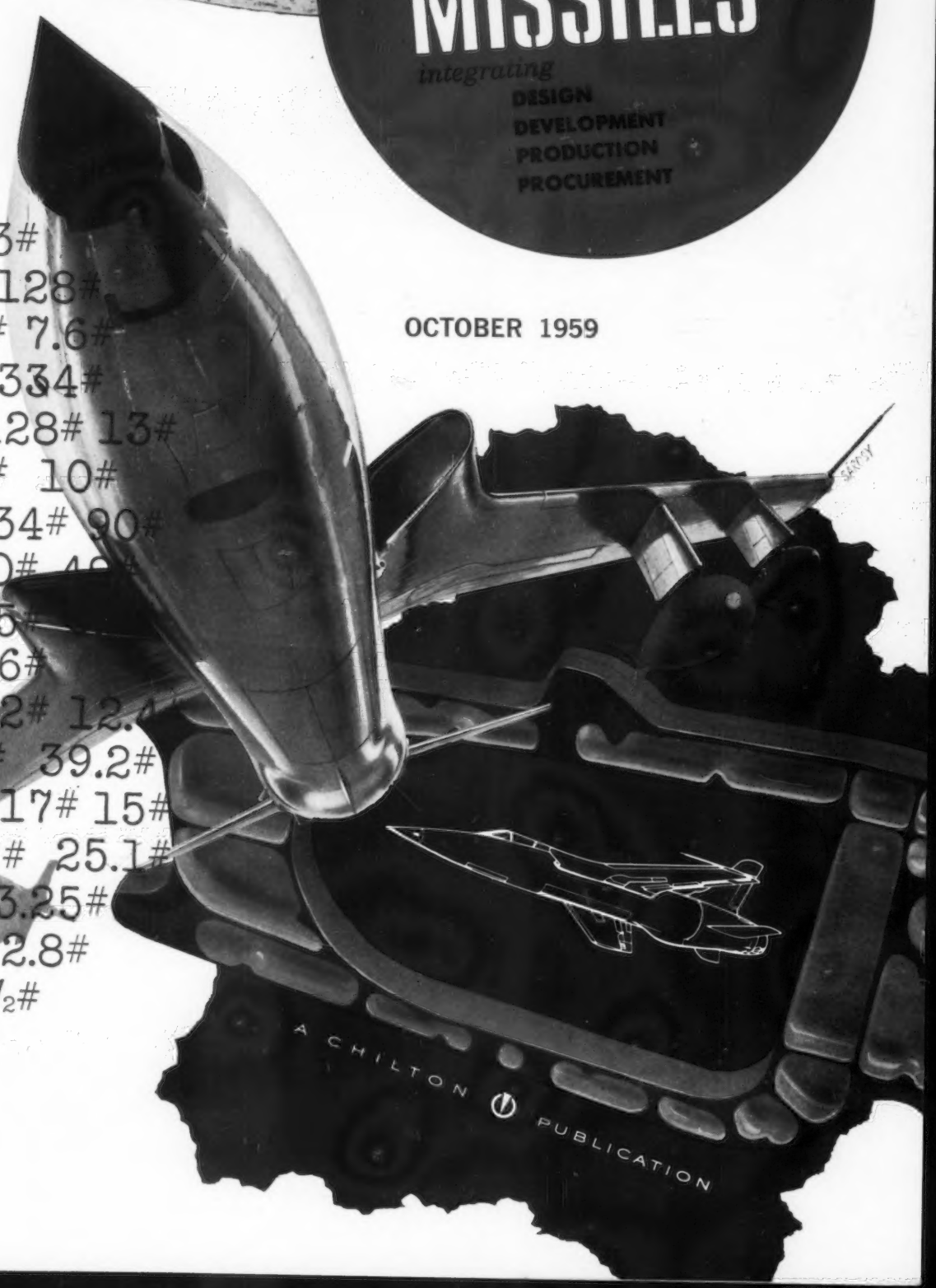
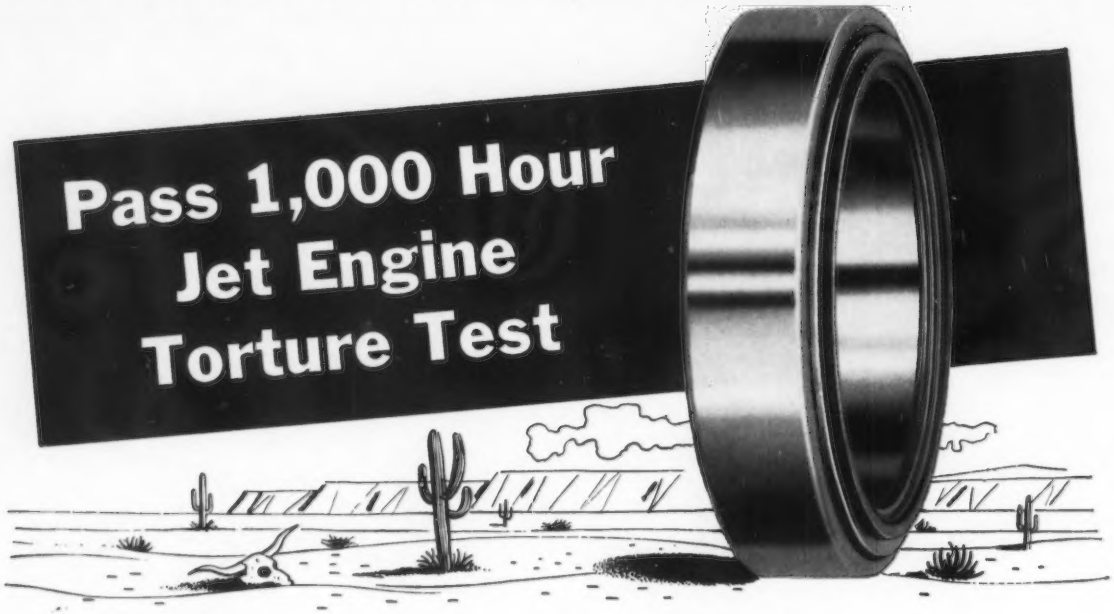
51.2#



OCTOBER 1959

A CHILTON PUBLICATION

SEALOL MECHANICAL SEALS



Conditions: 7,000 RPM 250°F. 0-250 PSI cycling pressures

Results: *NO SIGNS OF WEAR – ZERO LEAKAGE*

Picture a ¾" jet engine pump shaft running bone dry at 7,000 RPM, temperatures to 250°F. . . . hour after hour. Suddenly, water surges into the pump, slams into the shaft seal with momentary pressures running to 650 PSI. For 2 minutes, water is pumped at 250 PSI, then back to 4 hours of dry running.

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YOUR PARTICULAR SEALING PROBLEMS . . . may or may not call for "one thirteen" treated seals . . . or welded metal bellows seals . . . or heavy duty Flexibox-type seals . . . or low cost RS seals.

The important point is that you can look for longer life, lower costs and better performance when you contact your nearest Sealol Engineer for detailed information and recommendations.

SEALOL — *the versatile seal*
CURRENT APPLICATIONS

RPM	Shaft Size	Temperature	Fluid	Pressure
51,000	13/16"	400°F	Peroxide steam and nitrogen	0-10PSI
17,000	3"	225°F	Air Oil Mist	2-3PSI
37,500	1"	650°F	Mil-O-5606	20-30PSI
13,800	1 1/16"	—300°F	LOX	50PSI
3,500	1⅜"	270°F	Acetone, H2S04 and Phenol	80PSI
1,750	1⅞"	100°F	Mercury with 5% water	160PSI
173	1"	210°F	Tomato products	30PSI
25	1¼"	Ambient	Heavy Water	150PSI

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Circle 1 on Inquiry Card

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SLIDE on the ferrule

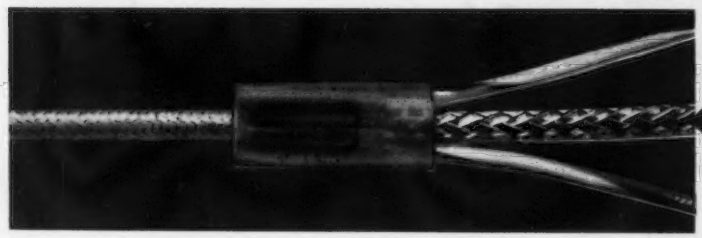
SLIP in the ground taps

CRIMP the three together

SNAP on the insulation

PRESTO!

the best insulated ferrule you can buy



How's that for speed! And the post-insulation of the Termashield Shielded Wire Ferrule is easily and quickly accomplished . . . you eliminate close tolerance cable stripping required by other techniques . . . you eliminate blind probing of taps into other type ferrules . . . you eliminate solder and burnt cable . . . you eliminate lost time . . . you eliminate doubt.

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AIRCRAFT AND MISSILES

DESIGN • DEVELOPMENT • PRODUCTION • PROCUREMENT

THE COVER STORY

This month's cover depicts the business end of an "extraordinary" aircraft built by "ordinary" methods—Republic's F-105 Thunderchief. This brawny fighter-bomber may shed as much as 40 per cent of its weight on a typical mission. The "Chief" gets a great deal of its muscularity from over two tons of raw forgings supplied by Wyman-Gordon and Ladish. Typical weights of forgings are given on left-hand side of cover picture.

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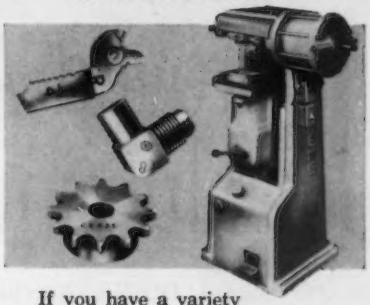
VERSATILE MARKER

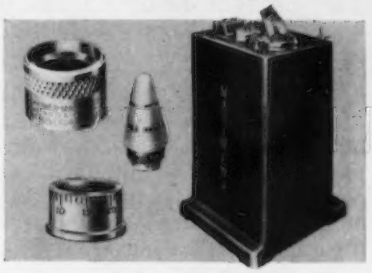
for rounds or flats



If you have a variety of shapes to mark, write for Bulletin FGP 20. Full description of Matthews General Purpose Machines.

HIGH SPEED MARKER

for round shapes



Continuous Marker for round, solid, tubular, or conical shapes. Can be equipped with Feed and Ejector for automatic operation. Write for Bulletin 146 C-9.

SPECIAL MARKERS

for special product shapes

Simple hand units or electronic marvels; all provide the simplest, most economical marking for special applications. Write, giving details or send sample product.

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Circle 5 on Inquiry Card

a new, improved ALODINE for aluminum

Cost Saving, Time Saving ALODINE 1200S Pre-Paint Treatment Protects Aluminum Best!

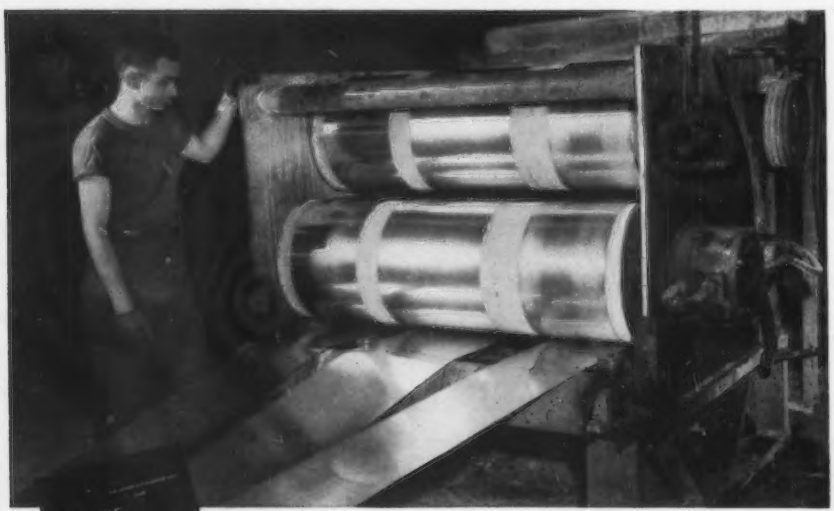
IN LESS TIME—ALODINE 1200S provides increased chemical activity for dramatic reduction in processing time . . . up to 50% in most cases! You get far faster processing than ever before, with the same high quality protection!

WITH LESS EQUIPMENT—You can install an ALODINE 1200S system quickly and conveniently, *without resorting to mechanical bath maintenance!* That means no dangerous, time consuming checking routines with the possibility of bath contamination always present!

AT LESS COST—ALODINE 1200S can be processed through continuous dip in the same time cycle other conversion coatings require for continuous spray lines! This dip technique reduces initial equipment costs, slashes maintenance costs to a minimum and allows aluminum fabricators to utilize conversion coatings more frequently for a wider range of product applications! Whatever the application method—brush, dip, continuous strip or spray—ALODINE 1200S may be the answer to your production problems.

FOR MORE FLEXIBILITY—Most important, its ease of operation, safety in use and versatility enables ALODINE 1200S to answer one of the most perplexing problems inherent in providing corrosion protection and paint bonding qualities for aluminum—the problem of constant, uniform quality. ALODINE 1200S is qualified under Government Specification MIL-C-5541.

Investigate cost saving, time saving ALODINE 1200S today! And whenever you have a chemical finishing requirement for aluminum—any type of aluminum—there's an ALODINE process available to protect or decorate the metal, and anchor the paint finish more securely.



Typical ALODINE 1200S strip line installation at ALSCO, INC. Strip from aluminum coil is fed into Alodine processing baths where it is cleaned, rinsed, deoxidized, rinsed, coated with ALODINE 1200S, rinsed and given a final acidulated rinse. Strip is then rewound, roll coat painted, roller formed into final shape, backed, inspected and packed for final shipment.

Write for Bulletin 1424A describing use of Alodine for aluminum fabrications of all types.

AMCHEM

ALODINE 1200S

another chemical development of **AMCHEM PRODUCTS, INC.**, Ambler 12, Pa.
(Formerly American Chemical Paint Co.)

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F-106A Delta Dart. Deadliest interceptor of them all! The F-106A carries both guided missiles and nuclear rockets that say "stay away" to all enemy bombers. F-106A power conversion equipment consists of the custom-built Chatham 28V30BP-A — a 30 amp, convection-cooled, selenium TR unit.

Reliable Chatham power supply flies high with CONVAIR F-106A!

The F-106A Delta Dart — jet interceptor made by the Convair Division of General Dynamics Corporation for the Air Defense Command — flies higher and faster than any other interceptor. In bad weather, in darkness F-106A operates unimpaired. Under these diverse, often times adverse conditions, Chatham power conversion equipment in the F-106A daily proves its mettle.

Chatham designed and made the 28V30BP-A specially for the Delta Dart. Chatham conformed fully with Convair's electrical specifications and restricted size and weight for high-level flight efficiency.

Compactness is the rule with Chatham power supplies. We make all our own solid-state components - silicon, selenium, germanium — and are never influenced by size of available components. Chatham thus makes power supply parts to fit the job and pares away unnecessary ounces and inches.

Send for folder T-26! It describes Chatham power supplies custom-made for Convair and other airframe companies. Many are immediately available. Or forward your specifications. We'll gladly recommend the design that will do the best job for you. Chatham Electronics, Division of Tung-Sol Electric Inc., Livingston, New Jersey. TWX: NK193.

CHATHAM . . . *world's leading supplier of airborne power conversion equipment.*

CHATHAM ELECTRONICS
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TUNG-SOL ELECTRIC INC.

phase two—all about you

Last month we gave you part of the story on the aircraft-missile engineer profile. Now, here's more data—those salary figures and career goals that I promised you. Also, a little about company benefits.

Let's start off with career goal. Of course, this depends on your age. At the low end—those under 25—the fellows are trying to reach the middle management group (this is what you say now). From 25 to 34 it's evenly divided between wanting top management or middle management. From here on out, there's a distinction. From 35 to 39, you're striving basically for top management. Middle management comes along as a close second. But now, the shoe reverses. Middle management seems to be the career goal of those between 40 to 44. Most of you between 45 and 49 wish to become a director of a company division. This was written specifically on the questionnaire. Middle management and top management are the goals of those in the 50 to 54 age category. Now when we get to 55 and over, most of these men have obtained their career goals and basically they're interested in doing one thing and one thing only—an excellent job in the industry. We were exceedingly pleased by the many fine comments of dedication to the aircraft and missile industry. It is interesting that our profile study reveals that the average engineer is not interested in top salary or unlimited advancement, but a chance to do a good job, achieve recognition, and provide top performance in his job. This certainly speaks well for those responsible for the defense and scientific achievements of our nation.

Changing jobs? If the aircraft and missile engineer wished to change his job, but financial gain was not the most important factor, what is the prime reason? Again, rated the most high by everyone right across the board, regardless of age classification, are more interesting work, more challenging position, and more job responsibilities. Basically, they feel that security, working conditions, and the caliber of people where they now work are fine.

Now, suppose you wanted to change your job for money. Just what do you fellows want? You ask an average of 15 per cent increase to remain in the local area. The majority (mode) ask for eight per cent. The mid-point or medium is around 12 per cent.

How about another part of the U. S.? Well, here the average goes up to 25½ per cent, with most asking for 18 per cent. The mid-point is 21 per cent.

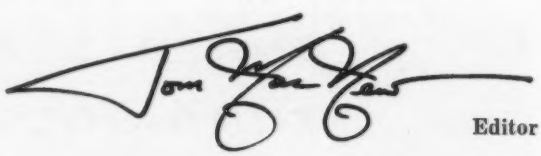
How much does the average aircraft-missile engineer make? The salaries range from under $5000 to over $50,000. Five years ago, the average salary was $7320 with most of the fellows making about $5750. We find that salaries today are almost double. The mode and median are $10,250 with the average at $10,959.

What do you want five years from now? Most of you want $11,750. But the average goes way up to $15,000. The mid-point is $13,916. Basically, you are asking for a $1500 raise in the next five years, provided our standard of living remains the same as it is today. Incidentally, the salary levels did not vary greatly in respect to the phase of industry employed. So, that grass isn't always greener on the other side of the fence.

How about company benefits? Most of you have a pension plan (93 per cent), 96 per cent receive health benefits and 97 per cent receive life insurance from the company.

Life insurance averages $15,000 per engineer with most of you receiving $8000 worth of insurance. This is more dependent on salary than any other item.

Now next month, we'll tell you about your home life, the cars you drive and how much money you're worth. And, just for fun, we even know what brand of cigarette you smoke!



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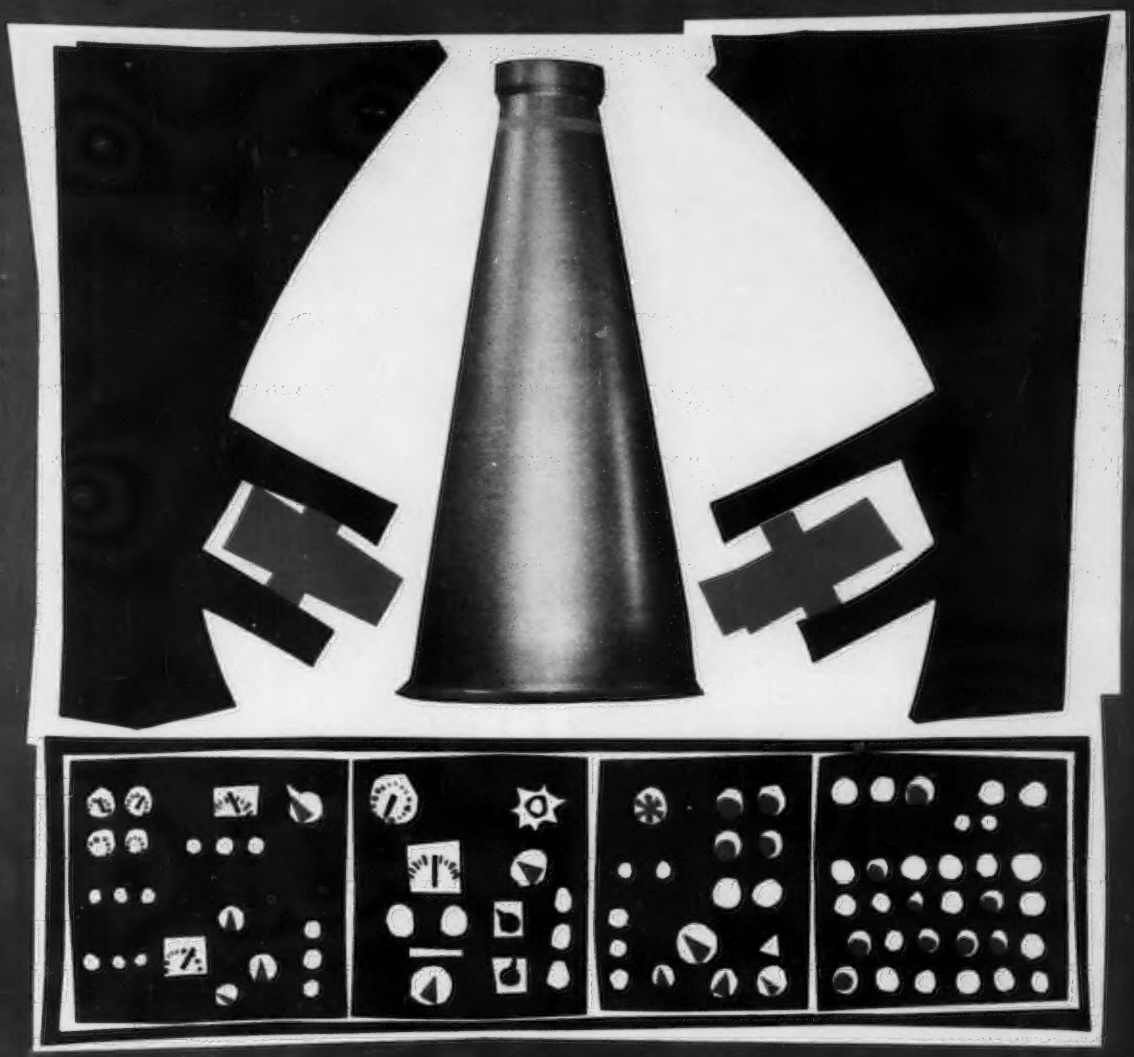
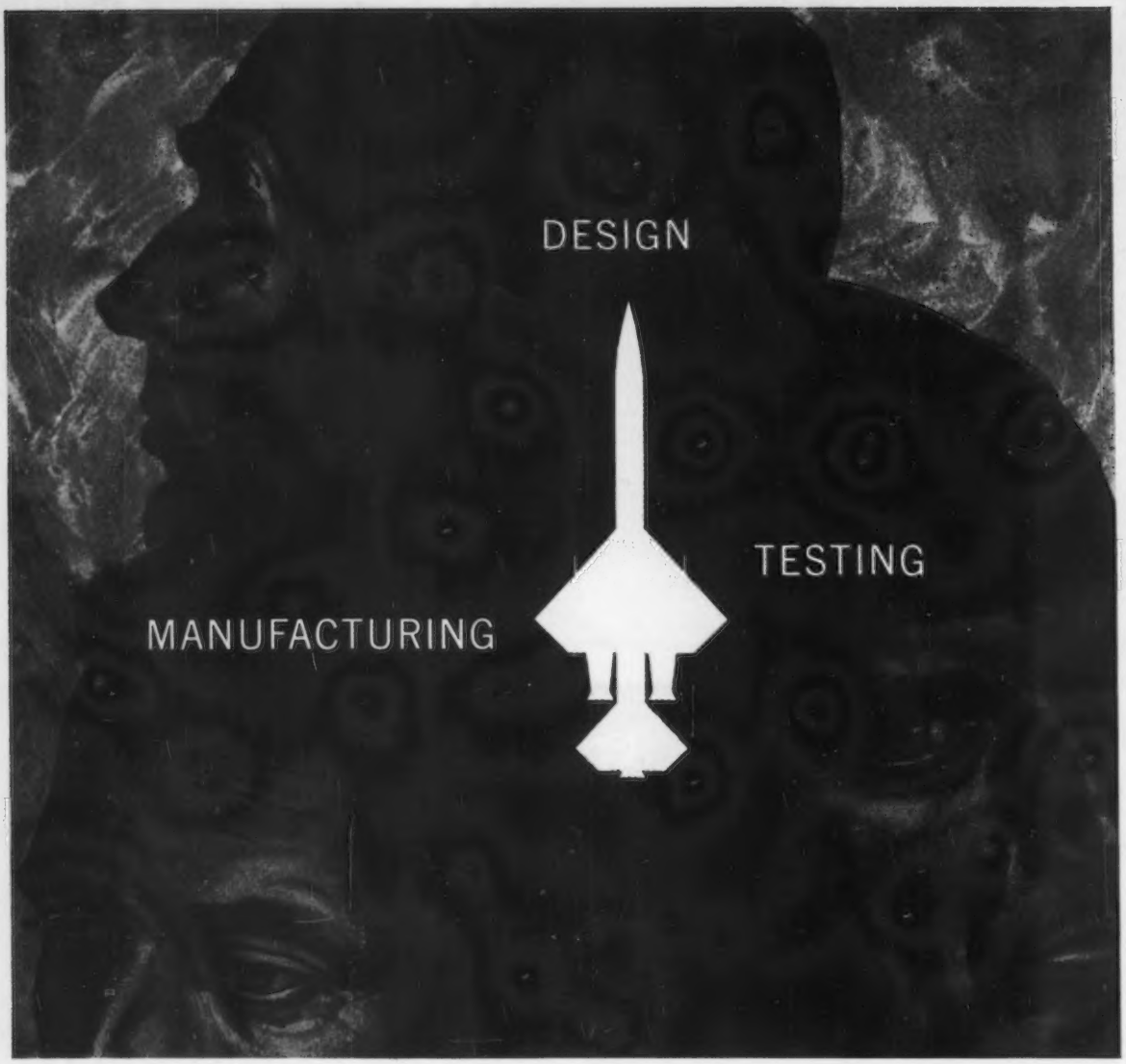


ELECTRONIC "MEMORY" SPIN FORGES IDENTICAL PARTS

"Dial in" essential engineering data. Hufford Spin Forge forms up to ½ ton of hardest metal one or a thousand times, without reliance upon human memory or artisanry. Because input is electronically applied, the effect is "a machine with a memory." Time between tool completion and delivery of a perfect part is brought to a minimum, because the machine "reports" to engineering precisely. Given approved data, each new start produces an identical part. Material savings and product uniformity become automatic. Complete automation, never before applied to machinery of this type, is the important "reason why." For information concerning the application of Hufford Spin Forging to your requirements, write: The Hufford Corporation, 1700 E. Grand Avenue, El Segundo, California...a division of The Siegler Corporation.

HUFFORD



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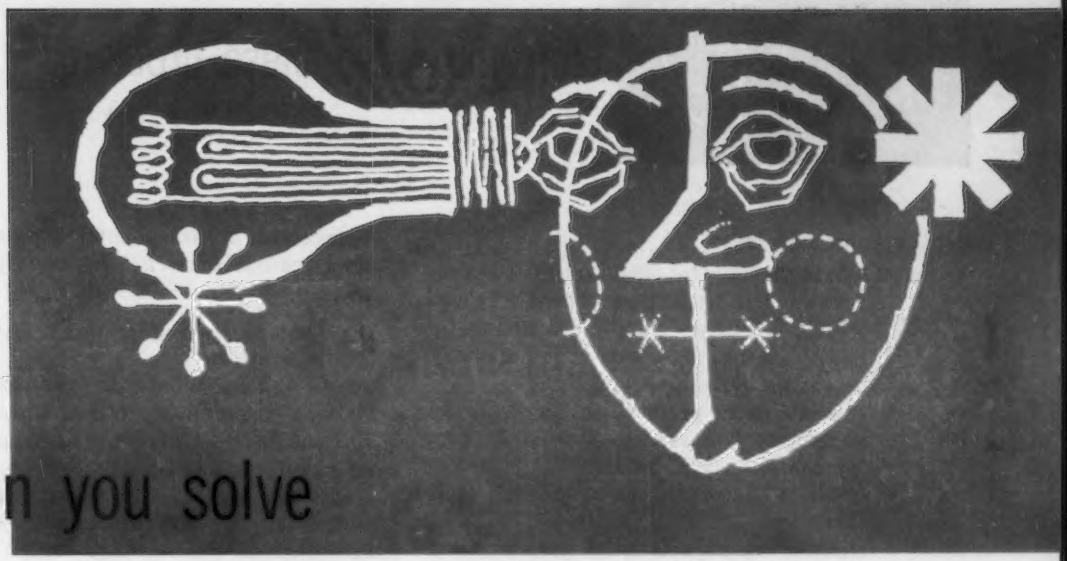
Deadly darting missiles and super-sonic fighters now prove in flight the advantages of Brunswick leadership in critical space-age components. Brunswick designs, tests and manufactures reinforced plastic and filament-wound super-sonic radomes to meet most *environmental* needs.

Critical Brunswick components are now specified and/or used in missiles such as the McDonnell Quail, Lockheed Kingfisher and Polaris, and Boeing Bomarc; in aircraft such as the Convair F-106A and B-58, North American F-108, McDonnell F3H, F4H and F-101, and Republic F-105.

From filament-wound radomes by the unique Strickland "B" Process to honeycomb-core, foam-in-place or anti-icing type radomes, Brunswick supplies the reliability of proven leadership. Write to Brunswick-Balke-Collender Co., Defense Products Division, 1700 Messler St., Muskegon, Michigan.

BRUNSWICK

MAKES YOUR IDEAS *WORK*



can you solve these problems?

the National Inventors Council is looking for bright ideas; yours may be the right one to bridge a vital technological gap

by S. Peter Kaprielyan

Would you like to fill a need and become successful? Here's an opportunity to kindle your inventive talents. There is no outright promise of glittering rewards in this instance. However, your personal contribution may serve directly to back our nation in the battle of ideas.

The National Inventors Council, with cooperation of the Army, Navy, and Air Force has compiled a list of technical problems. A number of these, of interest to A&M readers, is presented at the end of this article.

In making these needs known, the Council hopes to learn of new leads and developments which may not be known to military researchers. Despite extensive R & D programs within the government, there is a constant need for fresh approaches.

What The National Inventors Council Is

The Council is a civilian agency of the Government; its task is to bring to the attention of the military any inventive idea of potential value to national defense. It also refers to other Government departments or agencies, inventions which might contribute to national welfare. Established in 1940, in the belief that many firms and individuals, with creative ideas, did not know how to approach the Government with their ideas. Since then, many inventions have been processed by the Council. Current membership in the Council includes distinguished inventors and scientists from diverse fields. All members serve gratis.

continued on next page

can you solve these problems? . . . continued

How To Contribute Ideas

- Write directly to: The National Inventors council, U. S. Department of Commerce, Washington 25, D. C.; no special forms are required, nor is it necessary to engage an attorney.
- Submit each proposal as a separate document, typewritten if possible, giving complete description.
- Refer to the principles underlying each invention.
- Discuss any experimental work or tests conducted.
- Explain points of novelty or superiority of each invention as compared to existing devices or techniques.
- Include sketches or drawings, where they may help put your ideas across clearly; drawings need not be professional.

Answers To Some Appropriate Questions

Q. Will the council pay me for an acceptable idea or invention?

A. Payment depends on whether or not invention is used, and in what way. The Council is limited to evaluating and referring inventions to interested agencies or armed services; it has no authority to offer nor make payment. However, if submitted proposal is adopted, the branch or agency using the idea has the authority to negotiate with inventor for the right to use his invention.

Q. When may I expect a reply to my proposal?

A. It is the NIC staff's objective to handle each proposal in a matter of days. However, at times a deluge of mail may result in a delay of several weeks in reporting its findings. Correspondence is always handled in the order of receipt. If you wish immediate acknowledgment of a proposal, you may send it by registered mail, return receipt requested, or you may enclose a self-addressed postcard.

Q. Will a personal interview in Washington hasten the review process?

A. In general, no. Since locations of evaluating agencies are scattered geographically, initial reviews can be handled most expeditiously and economically by mail. If an indication of interest is received, arrangements may be made for personal consultation at the appropriate technical facility.

Q. Will I be notified of the Council's findings on my proposal?

A. Yes. Whatever the decision on your invention, you will be notified as soon as possible. If it is referred to the armed services, you will be so informed. If group to which it is referred wants further information, it will get in touch with you. If your idea is rejected, you will be informed of the reasons. The Council may be unable, however, to furnish you with a detailed critique of reasons for rejection.

Q. If no interest is expressed in my descriptive material, will it be returned to me?

A. No. Government regulations require that all material submitted and reviewed be retained as a permanent file. Therefore, duplicate copies of submitted material should be kept for your records.

Q. Can the Council furnish additional information on the problems?

A. Yes. The Council is glad to furnish additional data on the listed problems, if the request is in the form of specific questions.

Q. Can I obtain an R & D contract to perfect a problem solution?

A. The Council does not do contracting on its own and has no information about funding possibilities on any specific problem. Urgency of the problem, value of proposed solution, and competence of submitter are usually the determining factors on availablilty of funds for further development.

Q. If my idea is not patented, how does the Council protect my rights as an inventor?

A. All submitted material is held in strict confidence, and all possible safeguards are imposed to protect inventor's rights. Also each proposal is automatically stamped with date and hour of receipt by Council. Since a proposal becomes a part of permanent Government records, it is always available as evidence in any subsequent controversy over priority of inventorship.

Q. Where can I get a patent for my invention?

A. The only Government agency which is authorized to grant patents is the U. S. Patent

Office. If you are interested in applying for a patent, an informative pamphlet entitled "General Information Concerning Patents" is available for 15 cents from the Superintendent of Documents, Washington 25, D. C.

Q. Where can I find a patent attorney?

A. The Patent Office publishes the "Roster of Attorneys and Agents Registered to Practice Before the United States Patent Office." It lists registered attorneys and agents both alphabetically and by states and cities to help you make a selection. The book costs $1 and may be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. In addition, the national headquarters of the American Patent Law Association is located in the National Press Building, Washington 4, D. C. Upon request, that office will supply names of patent lawyers with offices in any location you specify.

Q. Is the Council's interest limited to ideas pertinent to the solution of the listed problems?

A. No. In general, the Council is interested in all ideas which may be of value to the military agencies or other branches of the Government. However, the Council is not interested in inventions of primary interest to a civilian market.

Q. Suppose I have a commercial product which I would like to sell to the Government. What is the procedure?

A. Detailed information on selling to the Government may be obtained from the "U. S. Government Purchasing and Specification Directory" which is available for 55 cents from the Superintendent of Documents, Washington 25, D. C.

List of Problems Needing Solution

● 639. PLASTIC LAMINATES.—Plastic laminates for airplane landing mats with the following physical characteristics: (a) 60,000 psi flexure strength; (b) 50,000 psi compressive and tensile yield; and (c) Modulus of elasticity 3,000,000 to 5,000,000 psi. If possible, the laminates should be capable of being formed with low-pressure techniques.

● 706. (a) AN ACCELERATED DRY BATTERY MnO_2 EVALUATION PROCEDURE.—An accelerated procedure for evaluating manganese dioxide for use in dry batteries. (b) AN ACCELERATED DRY BATTERY EVALUATION PROCEDURE.—An accelerated test method which will indicate quality and shelf life of dry batteries.

● 803. FREEZING POINT MEASUREMENT METHOD.—A compact, accurate, rapid method for determining freezing point of coolants in military equipment during Arctic operation. Equipment now in use is cumbersome and requires technical personnel to operate it. The desired equipment should be as easy to use as the conventional automotive hydrometer but of improved accuracy.

● 891. CONTROLLABLE RANGE DROPLET DISPENSER.—A droplet generator or dispenser which will operate without heating the liquid significantly above ambient temperatures. The device should yield large quantities of monodisperse droplets at controllable rates and in controllable ranges from 1 to 100 micron diameters. The device would be used to fill chambers and/or wind tunnels with liquid particulates of a known droplet size.

● 930. WATER PRESSURE-TIME GAGE.—A simple inexpensive accurate mechanical gage for reliable recording of the pressure time history of a water shock. The gage is intended for field use and should be self-contained. The pressure sensing and recording mechanisms must be insensitive to shock so that the pressure record will not be obscured. Operating depths extend to 200 ft, and shock pressures range from 200 to 15,000 psi.

● 965. ANGLE OF ATTACK.—A mechanism to measure angle of attack at hypersonic speeds. It must operate at high temperatures and in the fringe of the earth's atmosphere.

● 966. ALTIMETERS.—Pressure sensitive mechanisms for measuring pressure altitude to 500,000 feet or higher. Must be simple and generally suitable for installation on aircraft.

● 967. VIBRATION ISOLATION EQUIPMENT.—Devices which will preclude deleterious effects to sensitive airborne equipment which must function properly in high "g" environments and under severe vibration conditions. High fidelity of data from the basic sensor is required without attenuation of performance due to use of vibration isolation device.

● 968. DATA TRANSMITTING DEVICES.—Data transmitting devices which are accurate and repeatable to within 30 sec of arc. Means are required to precisely transmit electrical signals from sensors to equipment, indicators and subsystems utilized on weapons systems.

● 969. PRESSURE SENSING DEVICES.—A small size pressure sensor not dependent on bellows, diaphrgams or bourdon tubes, to provide an accurate indication of pressure in fluid lines and combustion areas.

● 970. TRAILING AERODYNAMIC DECELERATOR.—A trailing aerodynamic decelerator having high-drag-area-to-bulk and drag-area-to-weight ratios, to decelerate air vehicles with initial hypersonic velocity in combination with very low air-density. The decelerator must be capable of being stored within as small a volume as possible, must be designed for forcible and reliable deployment and extension, must exhibit excellent stability characteristics, and must operate at temperatures in the order of 1800°F without appreciable loss in strength. A capabil-

can you solve these problems? . . . continued

ity to change the drag area of the decelerator, while deployed, within a ratio of 100 to 1 is desired.

● 971. CONTROLLABLE LIFT DEVICE.—A controllable lift device to permit the slow descent of a man from an air vehicle to the earth. The device should be usable either in conjunction with a small stabilizing parachute or in lieu of any parachute. Should be capable of activation or deactivation as desired by the wearer. The device must provide excellent stability and be sufficiently responsive to control that the wearer may use it to assist in his movement over rough terrain while carrying normal combat equipment of the Infantry. Temperatures ranging from −65°F to +120°F should produce no effect upon the performance of the controllable lift device.

● 972. A REUSABLE PHOTOGRAPHIC STORAGE MEDIUM. —A reusable photographic storage medium incorporating resolution comparable to finest grain photo material; sensitivity comparable to fast photo material; processing as easy as magnetic tape, and with a visible image on a flexible support.

● 973. LOW LOSS, HIGH POWER FERRITES FOR USE AS MICROWAVE PHASE SHIFTER.

● 974. A BROADBAND MASER AMPLIFIER FOR USE IN MICROWAVE REGION.

● 975. A NEW METHOD OF ELECTRONICALLY (NOT WITH FREQUENCY CHANGE) SCANNING AN ANTENNA.

● 976. RELIABLE LONG LIFE CATHODE.—An efficient indirectly-heated, unipotential, thermionic cathode having 100,000-hr life in negative grid tube with current density of 500 mAdc/cm2.

● 977. A DRY BATTERY PERFORMANCE CAPABILITY INDICATOR.—A material is desired in the form of a sheet or strip which in aging changes colors or textures or colors and textures through a spectrum of colors and textures. The desired change indication should be brought about by the same ambient conditions that influence the deterioration of performance capability in dry batteries and the indications under the influencing ambient conditions should proceed at the same rate as the deterioration of performance capability proceeds in dry batteries.

● 978. CARBON BLACK EVALUATION.—A test procedure or device whereby the suitability of a lot of carbon black, for use in dry batteries, may be determined quickly and inexpensively.

● 979. PRECISION WINDS MEASURED BY ASCENDING ROCKET.—Determine wind speed up to 100,000 ft or at least 60,000 ft with an accuracy of one or two miles per hour during the ascent of a small rocket.

● 980. AUTOMATIC CLOUD DROPLET SIZE MEASURING EQUIPMENT.—One method to determine the drop size distribution in clouds is to collect the droplet on a slide, micro-photograph it, and count the droplets of different size ranges. This counting is a very time-consuming procedure. Therefore, an automatic or semi-automatic device to carry out this task would be extremely helpful.

● 981. CONTINUOUS CLOUD DROPLET SIZE MEASUREMENT.—Droplet sizes in clouds range from ca. 1 micron to 100 micron radius with concentrations from 10 to several 100 cc. A good method does not exist to measure the droplet size distribution from aircraft or from a balloon-borne device.

● 982. RESISTANCE THERMOMETER.—A material having a high temperature coefficient of resistance which can be drawn or formed into filament so that a resistance thermometer having physical characteristics of a platinum resistance thermometer be constructed which has a large resistance change such as possessed by thermistors.

● 983. PREFORMED SEMICONDUCTOR CRYSTALS FOR DEVICE FABRICATION.—Germanium and silicon single crystals grown in ribbons or rods with uniform physical and electrical characteristics to the sizes suitable for direct fabrication into diodes, transistors, solar cells, etc., is desired. The semiconductor material should have the properties equal to or superior than material presently used in germanium and silicon transistors. The new growing method should permit the direct utilization of the semiconductor for device fabrication thus eliminating the conventional wasteful and expensive slicing, lapping, and polishing operations.

● 989. TO DISCOVER NEW AND BETTER COMPOUNDS FOR USE AS FUNGICIDES IN MILITARY MATERIAL AND EQUIPAGE.

PRESENT SITUATION: No fungicide is available that is colorless, compatible with other components of a finish, stable to chemical change and actinic radiation, resists leaching, is non-toxic to humans, and economical both with regards to effective concentrations and cost.

✦

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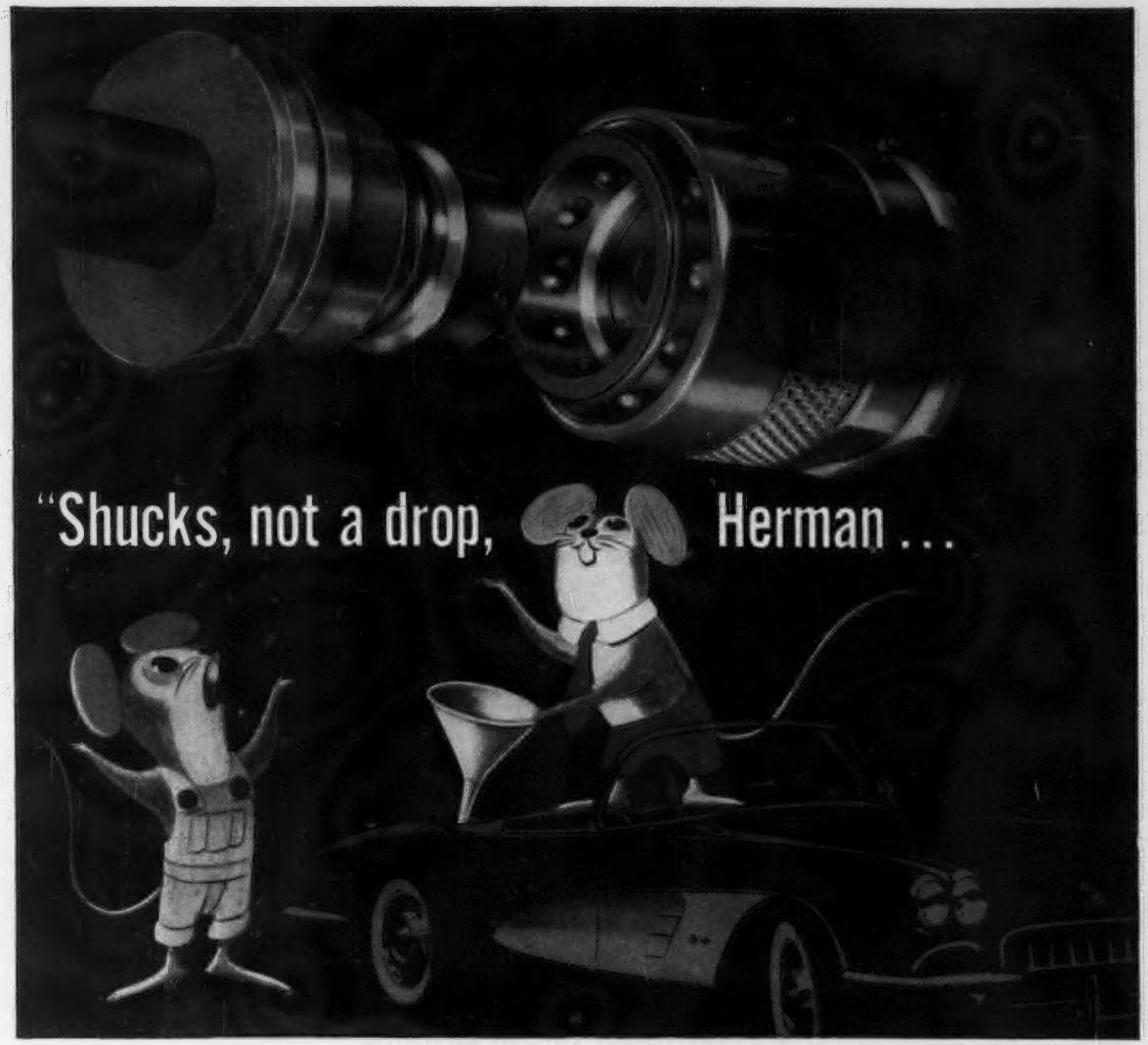

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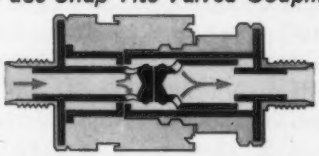
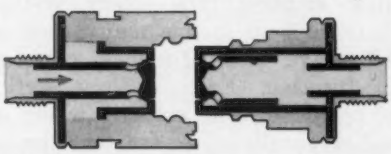
To use Snap-Tite Valved Coupling:



CONNECT—Full flow instantly



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The 15 Series valved coupling automatically snaps off the flow of the most volatile fluids when disconnected—with no leakage.

Snap-Tite's 15 Series valved coupling contains valves in both sections. Thus, the only fluid lost is that which clings to the outer metal surfaces. This coupling meets military specifications and can be used with fuels and other fluids to 3000 psi working pressure and 400°F. Sizes: ¼", ½", ¾", 1" in 6061T6 aluminum anodized; ⅜" in steel (electroless nickel plated), and 6061T6 aluminum.

Snap-Tite can provide the right valved coupling—with quick off-on action wherever coupling or shut-off is required—for most any use, most any fluid.

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ST-59-03

Now being delivered to USAF, F-105 is well-designed, versatile airplane. Has Mach 2 capability, and can deliver hydrogen weapon by LABS technique.

Thunderchief . . . producibility plus

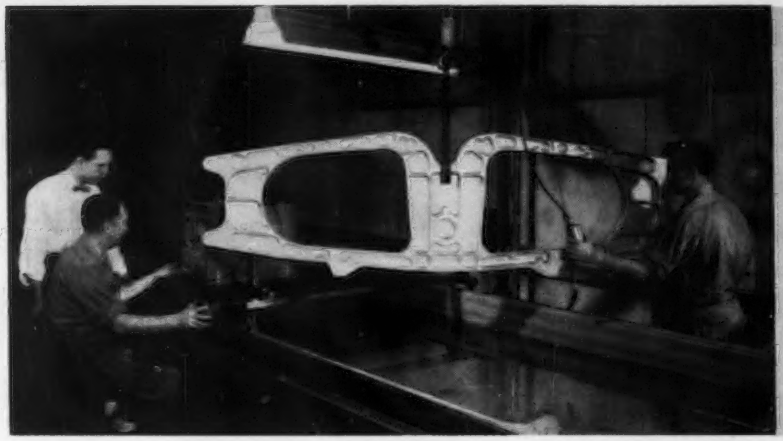
Republic brings spliced-fuselage, colony assembly to fighter production on East Coast; "usual" materials of construction result in "unusual" design; forgings play major role in airframe

by John P. Kushnerick

Dubbed "world's most powerful one-man plane" (26,500-lb thrust from a J75-P-5), Republic's F-105 is designed for assembly from remarkably conventional materials and processes. The Thunderchief is comprised essentially of 7075 aluminum sheet, and forgings, held together with rivets and bolts. Adhesive bonding, brazing, and chemical milling are almost totally absent. The alloys customarily referred to as the "hot metals" are used only in specialized areas where their advantage is clear cut. There is no honeycomb, some limited magnesium, titanium only in speed-brake and afterburner areas, and chrome steel in a few structural parts. What has been done with conventional materials and assembly techniques is all the more remarkable, for F-105 is a "sophisticated design," incorporating area rule, variable inlet ducts, conical-camber airfoils, and "flower-petal" speed brakes. How the airframe is assembled is an interesting departure from usual "East Coast" methods of producing fighter aircraft.

Colony System

Republic employs "the colony system." The aircraft is built-up in five major sections: wings, nose-fuselage, center-fuselage, rear-fuselage, and aft-fuselage. Each of these sections is fabricated complete in a "colony," where one man has final responsibility to see that the section of the airframe his "colony" sends to final assembly, is complete in every detail. Should any



Front frame in fuselage is 7075-T6 aluminum forging. Part is 79-in. long, 27 in. wide, and weighs 334 lb. Technicians at Wyman-Gordon Co. are shown using ultrasonics immersion to check soundness of forging.

discrepancy arise in final assembly, responsibility can easily be affixed, and the problem remedied, without the customary entanglements.

Fuselage Splice

Departure from "whole unit" type construction of the fuselage was made to increase production with least increase in tooling and manpower costs. The spliced fuselage is the departure from conventional "East Coast" methods. (Tooling, and procedural specifications are illustrated on pp. 18-19.)

When the nose, center, and rear sections of the fuselage arrive on the mating line from their respective "colonies," they are placed in a large jig, trimmed to size, and riveted into one unit. Aft section of the fuselage is joined in another jig. It is not permanently riveted to the rest of the fuselage since it must be removed periodically for access to the engine.

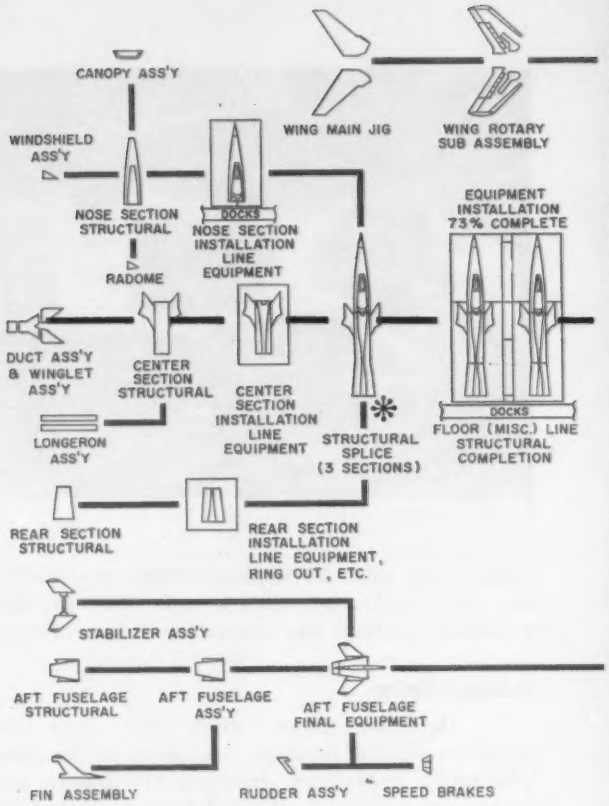
The center section is positioned in the splicing jig first. Exact positioning is through "jackpoints" near the main spar. The nose and rear sections are then installed in the splice jig. They are positioned relative to the center section using indexing pins in a sliding, crank-operated carriage on the base of the splicing jig.

Trimming the ends of center, nose, and rear sections, which ultimately butt together, is accomplished with dual, 6-in. diam circular blades, ganged about 6 in. apart. Saws are an integral part of the splice jigs. Blades are adjusted to skin thickness for depth of cut. A portable air supply is used for the mechanism which holds the blades against the fuselage and moves them through a circumferential cut. The blades are driven electrically. After all butting surfaces

Republic uses "colony system" for assembly of F-105. Five major sections are fabricated complete by small groups then sent to final assembly. Near end of line equipment is installed and checked.

Thunderchief . . . continued

are trimmed flush, the sections are moved together in the splice fixture and permanently joined by riveting. When sufficient structural components are in place to prevent warping or distortion, the fuselage is moved into the main assembly line (see flow chart).



In the Colonies

NOSE SECTION of the fuselage is very conventional. It is built-up in small fixtures using 7075 details for the skeletal work and is assembled with hand tools by riveting. Most of the electronic gear is eventually housed in the forward nose so a large portion of the skin is made up of laminated fiberglass and resin in the F-105-B. Filament winding is used to produce the larger F-105-D nose. This unit is sub-contracted to Brunswick-Balke-Collender. The all-weather "D" uses the ASG-19 fire control system, including NASARR monopulse radar by Autonetics Division of North American Aviation.

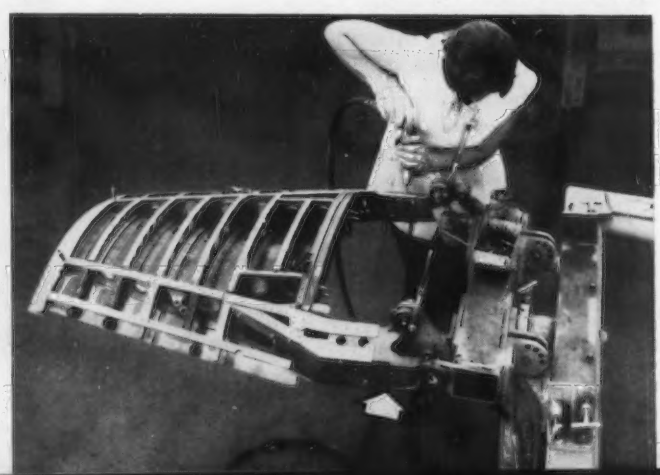
CENTER SECTION makes extensive use of the big forgings mentioned earlier. Main loads are carried by two forged frames. The forward frame is 7075 aluminum and forms an integral part of the air inlet. It is a product of Wyman-Gordon and the 50,000-ton "heavy press program." This frame carries the shear loads transmitted by front wing spar. The rear frame could be considered the focal point of the aircraft structurally. It is made of Hy-Tuff steel (MIL-S-8699) and is supplied by Ladish Co.

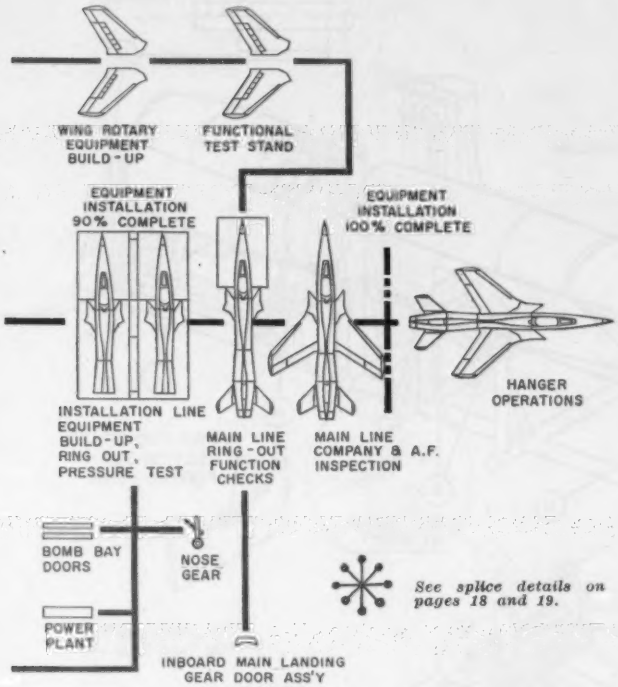
The weapons bay is also in this section of the fuselage. It contains a huge (approx. 12-in. diam) cylinder which ejects the weapon with a 30,000-lb push. Bay doors tuck neatly into fuselage (when opened) on forward and aft cam tracks. Hydraulic pressure holds the doors closed and open.

REAR SECTION of the fuselage increases in diameter from front to back; this is because of the area rule design. Most of the aircraft engine

View in nose section "colony" shows 7075 aluminum details that are eventually covered with "conventional" aluminum skins.

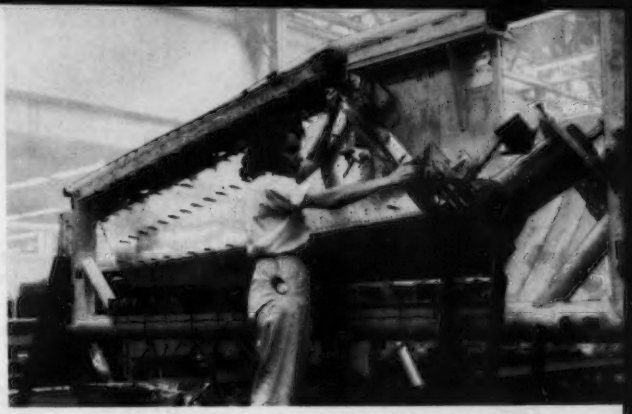
Four identical speed brakes are fabricated in table-top fixtures. Titanium and Inconel X details are joined to forged hinges (arrow) with hand tools. This type of assembly is very dominant in F-105 fabrication.




WING ROTARY EQUIPMENT BUILD-UP
FUNCTIONAL TEST STAND
EQUIPMENT INSTALLATION 90% COMPLETE
EQUIPMENT INSTALLATION 100% COMPLETE
HANGER OPERATIONS
INSTALLATION LINE EQUIPMENT BUILD-UP, RING OUT, PRESSURE TEST
MAIN LINE RING-OUT FUNCTION CHECKS
MAIN LINE COMPANY & A.F. INSPECTION
BOMB BAY DOORS
NOSE GEAR
POWER PLANT
INBOARD MAIN LANDING GEAR DOOR ASS'Y

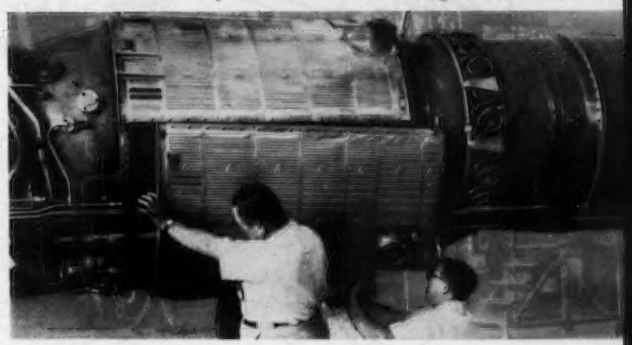
See splice details on pages 18 and 19.

"COLONY SYSTEM" PRODUCTION FLOW



Typical combination of heavily stressed forging with hand-drilled and hand-riveted skins is shown in right-hand tail slab. Root end forging (arrow) is shrunk fitted onto steel tube which passes through fuselage to join left hand tail slab.

Titanium sheathing and insulating blankets are placed around powerful J-75 powerplant to protect aluminum fuselage from heat.



accessories are housed in this part of the fuselage.

AFT SECTION is attached with four bolts at the main longerons. This provides strength, yet allows for quick removal and engine access. Most of the fuselage loads are carried to the center-section forgings in the longerons which are built-up of machined aluminum extrusions and sheet metal.

Completed aft section has two very interesting subassemblies:

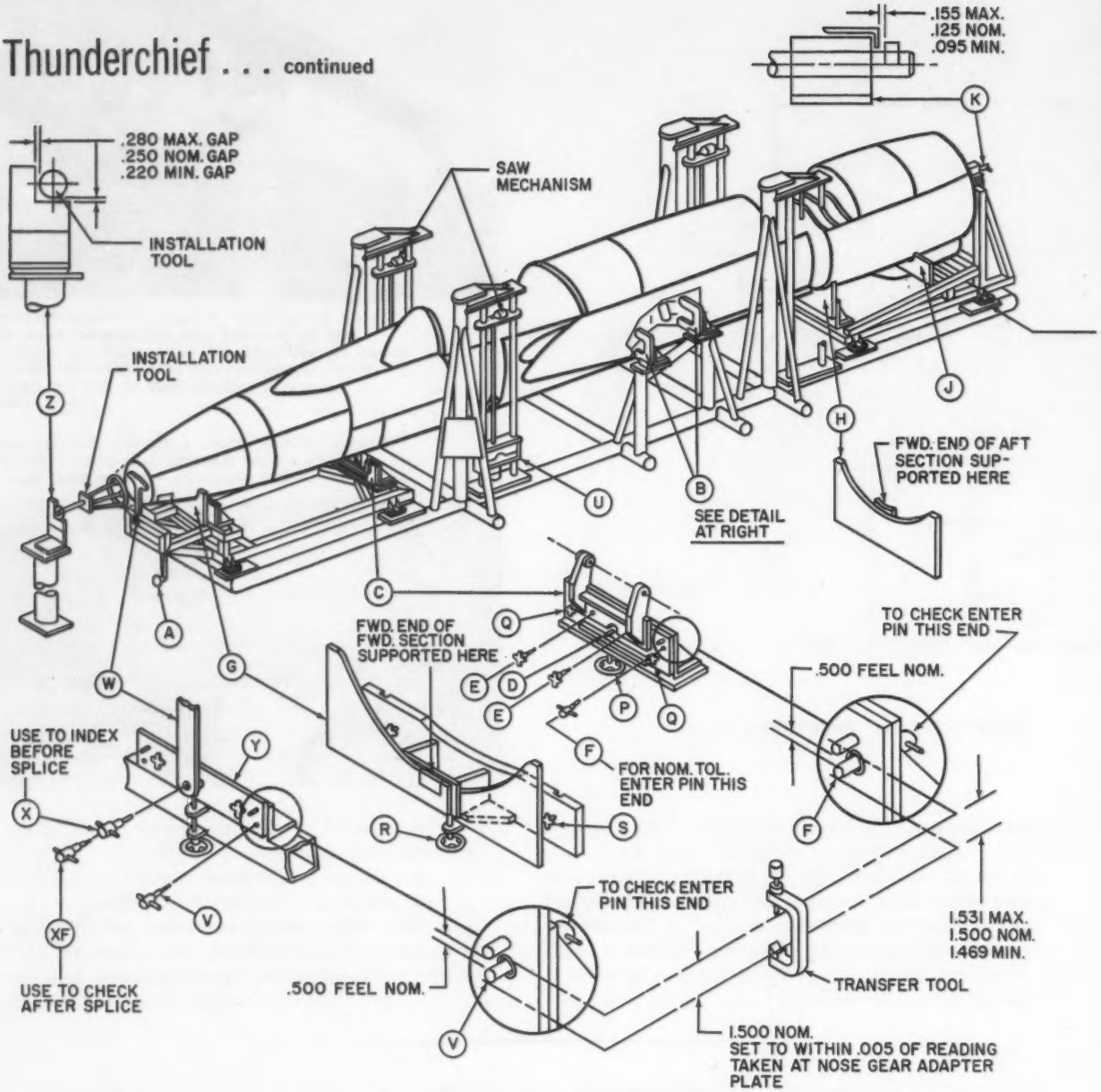
- "Clover leaf" speed brake.
- Single-unit horizontal stabilizer.

THE SPEED BRAKE forms the last 36 in. of the fuselage when retracted. It consists of four flap-like surfaces which open and close like the

text continued on page 20

WHO'S WHO IN F-105 SYSTEMS

Bendix Aviation Corp.	Main landing gear
Bendix, Red Bank Div.	Electrical, dc source
Bendix, Eclipse Pioneer Div.	Air data computer, flight control system Flight instruments on WADC Phase II panel Steerable nose wheel
Collins Radio	Modular electronics, radio navigation Flight instruments on WADC Phase II panel
General Electric Co. Light Military Electronic Equip. Dept.	Fire control system MA-8 Flight control system FC-5 Ordnance, M-61 Vulcan cannon
Goodyear Aircraft	Brake system
Laboratory For Electronics	Doppler radar, "inertial" navigation system (F-105-D)
Lear Inc.	Variable intake control system
Pratt and Whitney	Powerplant
North American Aviation Autonetics Div.	Radar fire control (F-105-D) NASAAR monopulse
Sundstrand Aviation	Alternator drives, electrical system
Sperry Rand Corp. Vickers Inc.	Hydraulic system
Westinghouse	Electrical equipment (majority)



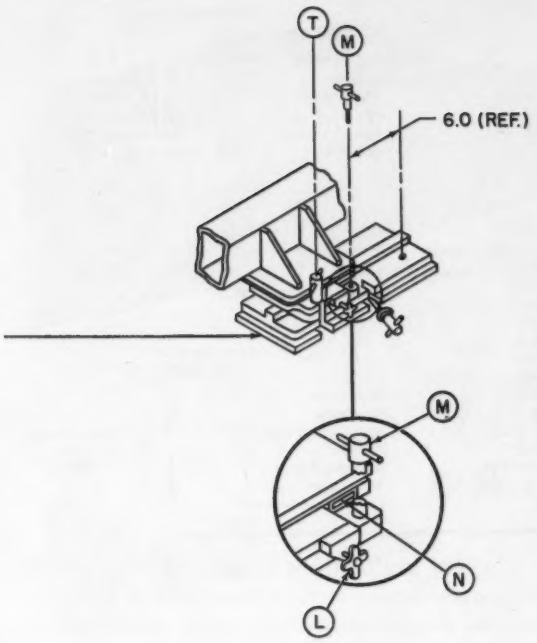
OPERATING INSTRUCTIONS

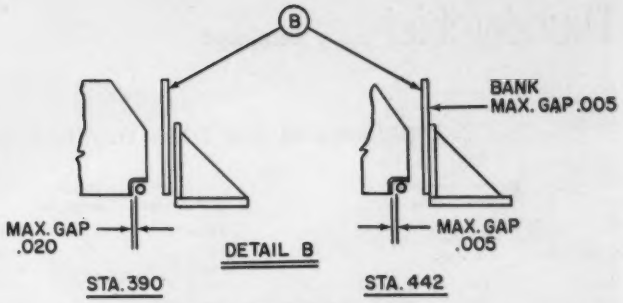
1. Crank (A) fwd. carriage as far fwd. as 1st pin (M) index pt.
2. Crank aft carriage as far aft as 2nd pin (M) index pt.
3. With crane, place completed fuselage center-section in jig and secure by wing hinge pt. adaptor plates (B).
4. With crane, place completed fuselage fwd.-section in fwd. carriage. Locate nose gear trunnion adaptor plate (C) over centralizing pin (D) and on bar rest. Insert shoulder screws (E) and tighten. The fwd. end is supported by a contour board (G). Bolt adaptor plate (W) in place in Frame At STA 83.50.
5. With crane, place completed fuselage aft-section in aft carriage. Seat in fwd. contour board (H), and aft padded support (J). Slide 4 cone fitting locators (K) in place and draw up bolts.
6. Crank (A) fwd. and aft carriages as close as possible to the center section. The following adjustments are made as necessary.

LATERAL ADJUSTMENT

Lateral adjustment is provided to eliminate or split any mismatch between the center section and the fwd. and aft section.

a. Adjust by turning the jig knobs (L) at both ends of the fwd. (or aft carriage). If the assembly must move the other may loosen the jig knobs





WING HINGE ADAPTER PLATES

NOTE: THE FUSELAGE SHALL BE FREE FROM ALL RESTRAINT, WITH ADAPTERS RESTING ON JIG POINTS.
WITH (3) ADAPTERS RESTING ON JIG POINTS, THE FOURTH POINT SHALL NOT BE RAISED MORE THAN .005 FROM THE JIG.

(L) and proceed to tighten the jig knobs (L) on the opposite side.

b. A feeler reading should then be made between (M & N). These readings must be within tolerance at either end making the correction at the end opposing the splice. (See view A-A).

c. Jig knobs on the opposite side are tightened to lock the location.

VERTICAL ADJUSTMENT

A vertical adjustment is provided to match the fwd. and aft section to the center section at the terminus of the center section only.

a. The nose gear adaptor plate (C) and the contour plate (G) are adjustable up or down by turning the hand wheel (P) or (R). After the best match is made, the position is locked by tightening the jig knobs (Q) or (S).

b. The amount moved from nominal may be set into a transfer gauge across the dowel pin and check pin (F).

c. Plate (Y) is jacked or lowered to the same height as nose gear adaptor plate using the transfer gauge to set same distance across dowel pin and check pin (V).

d. Contour plate (G) is then jacked or lowered until pin (X) locates in adaptor (W) and plate (Y).

e. On AFT Section, remove taper pins in upper (2) cone fitting locators (K) when raising or lowering contour board (H). After best match is made, check gap between housing block and collar on shaft (K).

NOTE: FUSELAGE CONTOURS IN AREAS OF SPLICE MUST MATCH WITHIN TOLERANCE AFTER ALL ADJUSTMENTS HAVE BEEN MADE AND LOCKED IN POSITION. CONTOUR BOARDS (G) and (H) **NOT** TO BE USED TO CHECK FUS. BCL.

7. Both carriages are cranked away from the center section (6.0 in. ref.), indexed with pins (M), and locked down with swing bolts (T).
8. The saw mechanisms (U) are swung into position and indexed with pins.
9. Start saw motor and automatic feed. Let run (automatic stop).
10. Return saw to starting position.
11. Remove index pins and swing saw unit (U) out of the way.
12. The carriages are unlocked, swing bolts (T) and index pins (M) removed, and cranked (A) (6.0 in. ref.) up to position for splicing, index pins (M) inserted and swing bolts (T) tightened. Check for skin splice gap allowance at Sta. 300 and Sta. 525.
13. Splice is riveted.
14. After splice is completed, remove index pin (X) from adaptor plate (W). Insert checking pin (XF) thru adaptor (W) and plate (Y). Pin (XF) must enter fully with only slight pressure.
15. Remove checking pin (XF), and adaptor plate (W) from fuselage. Remove (4) splice cone locators (K), lower fwd. and aft contour boards, (G) and (H).
16. With fuselage supported by wing hinge adaptors (B) and nose gear trunnion adaptor (C) only, drill (3) #50 leveling holes. Refine level lugs in nose section. Mount installation tool on radome attach holes on hinged nose assy. Adjust compression bolts on STA 83.50 to meet tolerances shown between installation tool and checking plate (2).

Thunderchief . . . continued

MAJOR FORGINGS IN THE F-105 THUNDERCHIEF

From Wyman-Gordon Co.
(7075-T6 aluminum)

Part Name	Shipping Weight, lb.	Size
Spar (2)	334	79" long x 27" wide
Spar Caps (4)	90	68" long x 13.4" wide
Frame	175	96" long x 30" wide
Spar Caps (4)	128	102" long x 16" wide
Fitting (2)	7.9	12.68" x 10.58" rectangle
Cylinder Attachment	7.6	25.3" long
Rib	13	11" x 7¼" rectangle
Fitting	16.4	15.84" long
Link	10	19" long
Support	2.7	19" long
Fitting	4.3	8.8" x 7.4" rectangle
Support (2)	49	24" long
Fitting	4.1	14.39" long
Fitting	6.1	13.62" x 12.82" rectangle
Hinge	5.1	About 8" square
Fitting	3.2	12.54" long
Link Stabilizer	2.5	15" long
Arm Torque	2.8	10" long
Barrel	12.4	9.82" long
Fitting	11.8	12.32" long
Cam Fitting	17	25.5" long
Cam	16.5	25.5" long
Body (2)	15	17" long
Body Rudder	22	14" long
Support	11.7	13.4" long
Support	25.1	8" x 8" rectangle
Wheel	20.6	16¼" diameter
Bracket	11.6	14" long

(2K-60-magnesium)

Part Name	Shipping Weight, lb.	Size
Support	2.8	16.86" long
Flange Wheel	13.25	16.25" diameter
Wheel	39.2	15.5" diameter
Support	1.7	4.44" square
Side Rim	9.8	18.25" diameter

(alloy steel)

Part Name	Shipping Weight, lb.	Size
Piston	20½	20½" long
Brace	51.2	22¼" long

From Ladish Co.
(alloy steel)

Main Frame	Total as-forged weight, 1964 lb.
Fin Fittings	
Main Landing Gear Brace	
Trunnion	
Bay Latch Fittings	
Wing Frame	
Landing Gear Trunnion	

petals on a flower. This gives full 360 deg braking around fuselage and minimizes buffet and trim change. The brake is fabricated from AMS 4908 titanium and is lined on the inner surface with Inconel X; since, in the closed position brake forms a convergent-divergent nozzle for afterburner gases. The petals can be operated four at a time or two at a time. During landing, however, only the two lateral petals can be energized. Purpose is twofold: One, upper brake would foul drag parachute, lower brake might strike runway; two, lateral petals produce adequate drag to allow fairly high engine rpm in landing approach. Use of four petals might produce too much drag and not leave adequate reserve rpm when landing with heavy loads.

Speed brake is built-up in tabletop fixtures, and is assembled with hand tools. It is one of the few areas where special alloys are used. Inner lining of Inconel X is applied in transverse overlapping strips to compensate for expansion. They encounter temperatures of about 1000°F. All petals are identical and interchangeable.

THE HORIZONTAL TAIL uses no elevator. It is made up of a right and left "slab," joined by a flash welded (4130), steel tube, which passes through the fuselage. The tube is U-shaped to clear the afterburner. Joining the tail slabs to the tube is effected by heating the 7079 forgings on the root end of each slab and shrink fitting them to the steel tube.

In operation, one hydraulic actuator moves the crossbeam, thus moving the two slabs in unison.

Vertical tail incorporates a leading-edge air scoop at the fuselage juncture. Air is ducted to the burner area for cooling. Duct system is essentially magnesium.

WINGS are built-up in tailored jigs; chord being perpendicular to floor level during fabrication. The wing contains two main spars, which run span-wise, and one spar which runs chord-wise. The latter is called the transverse spar. This load carrying member is a machined forging. It is fabricated on a Kearney and Trecker tape controlled milling machine.

The two span-wise spars are also 7075 aluminum forgings. In these units, however, machining precedes forging. The spars are machined, then shipped to Wyman-Gordon where compound curvature is permanently imparted by quenching the spars in the forging dies.

Wings are covered with sculpture-milled skins (some will be chem-milled in F-105-D), contoured before being attached to the skeletal work of the wing.

The main gear tucks into the thicker root section of the wing. There is no provision for carrying fuel in the wings.

INLET DUCTS on Thunderchief are very distinctive. They are "swept forward" from the fuselage. Inlets incorporate variable-geometry openings. Oblique shocks are kept away from the fuselage and wing, and normal shock is made to enter the duct at the optimum position with this system. This allows intake of about 1,000,000 cu ft/min without "choking" the engine.

Additional air intakes are installed in the wheel wells for ground operation.

✦

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Another application where dependability and efficiency count most . . .

VICKERS HYDRAULICS ON REPUBLIC F-105

Highest overall efficiency and minimum heat rejection of the pumps . . . and exceptional dependability of all components were decisive factors in the selection of Vickers Hydraulics for the powerful Republic F-105 Thunderchief.

The principal Vickers components in the F-105 are illustrated at the left. These, and all other Vickers aero hydraulic units and systems are tailored to airborne needs—light, compact, durable, dependable and efficient. Also, back of all Vickers products is a well organized and factory-staffed service organization.

For further information ask the district office in your area listed below for Bulletin A-5200-E.

Vickers 3000 psi Variable Displacement Piston Type Pumps supply power to the main control and utility hydraulic systems.

Vickers 3000 psi Constant Displacement Piston Type Pump operated by ram air turbine supplies emergency hydraulic power.

Vickers Constant Displacement Piston Type Hydraulic Motors perform critical functions requiring their high efficiency and distinctive control characteristics.

Vickers Flow Sensitive Pressure Regulator permits emergency ram air turbine to generate needed hydraulic flow down to minimum airspeed.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

HIGH-STRENGTH ALUMINUM CASTINGS

Complex machining was avoided on the T-38 canopy supports with castings of high-strength Ductaluminum.
56156
72-156
U.S. AIR FORCE

DUCTALUMINUM CASTINGS TO MIL-C-21180A SAVE NORTHROP $1,500 PER T-38 JET

Using high-strength Ductaluminum castings for three structural canopy supports on the new T-38 supersonic jet trainer saved Northrop $1,500 per ship. The alternative—a fabricated assembly of hog-outs from forgings and extrusions—would have occupied greater space, weighed nine pounds extra, and cost $1,500 more for each aircraft.

Northrop's example proves that high-strength castings with guaranteed mechanical properties (in the *casting*) can be used in place of forgings, extrusions or weldments for structural parts at considerable savings to the manufacturer. Consider these advantages of castings: lower tooling cost, intricate design, cast-in lightening holes and bosses, and rigid, one-piece construction.

Ductaluminum castings produced to MIL-C-21180A (ASG) specification provide the following guaranteed properties* in highly stressed areas.

	UTS	YS	%EL
Ductaluminum 356T	38,000	28,000	6.0
Ductaluminum 356S	42,000	35,000	3.0
Ductaluminum 355	50,000	40,000	3.0

*Higher properties can be guaranteed in castings with favorable design characteristics.

A-3198

Plants at Mahwah, New Jersey and Rivera, California

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LIGHT METALS DEPARTMENT
MAHWAH, NEW JERSEY

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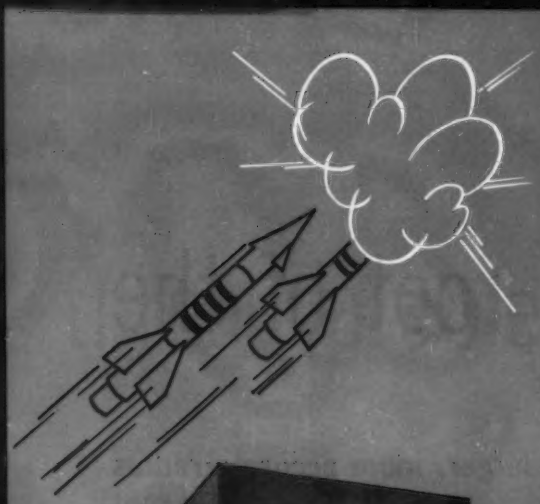

Cincinnati Hydroform · Hydrospin

make the nose sections flow for TAPCO GROUP of *Thompson Ramo Wooldridge Inc.*

Tapco Group, contractor to supply nose sections for the highly accurate, air-to-surface "Bullpup" missile, employs Hydroforming and Hydrospinning to form these parts at high production rates.

Photo at left shows preforms being produced with minimum thinout, on a Cincinnati 32″ Hydroform®, at rate of 90 per hour. Preform is of 6061 Aluminum, 14″ major diameter x 13″ deep x ⅛″ wall thickness. Preforming is a sub-contract operation by Jones Metal Products Co., West Lafayette, Ohio.

The preform is heat-treated, then "*chipless machined*" on the two-roller Cincinnati Hydrospin® in two operations (bottom photo). First spinning roll-flows the preform to 20″ length x 12″ major diameter x 0.080″ wall thickness, in 3½ minutes. Final spinning increases part length to 40″ and reduces wall thickness to 0.040″. Floor-to-floor time, 4¼ minutes.

For your missile metalworking, you'll save time and money by teaming-up with Cincinnati Hydroform and Hydrospin machines. Call in a Meta-Dynamics Division field engineer for detailed information.

Hydroform/Hydrospin

META-DYNAMICS DIVISION

Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
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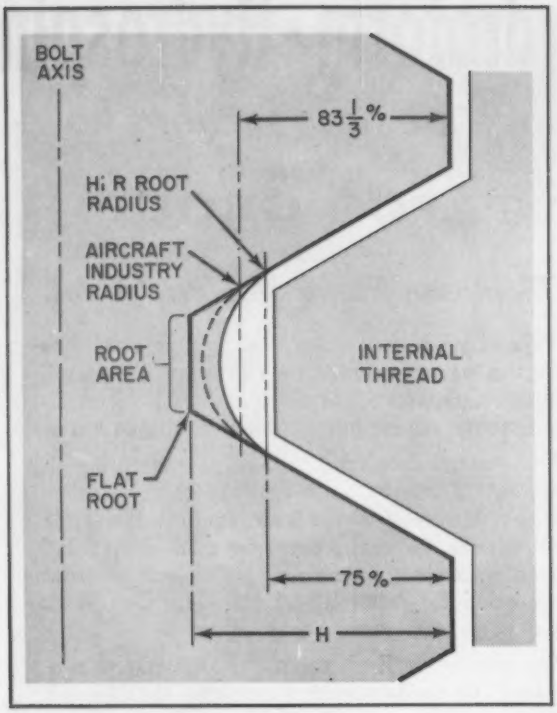


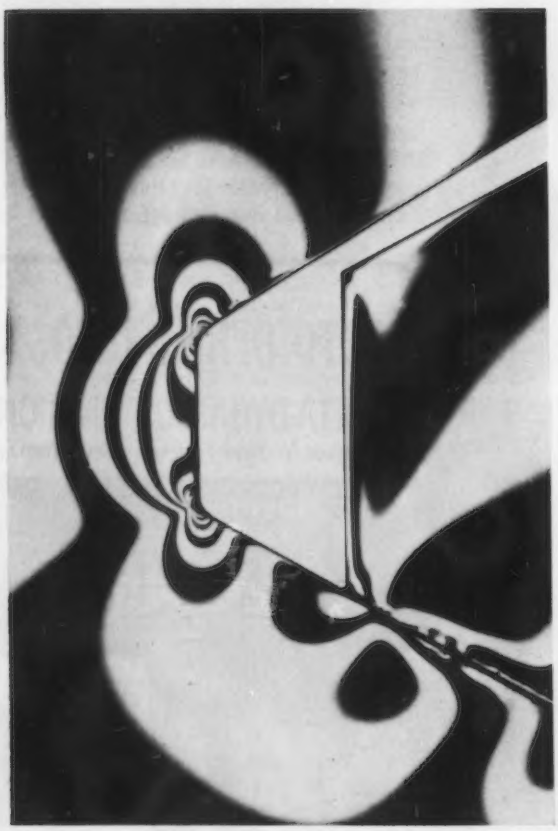
root of the

larger, more accurate radius in thread root improves fatigue strength of bolt-type fasteners

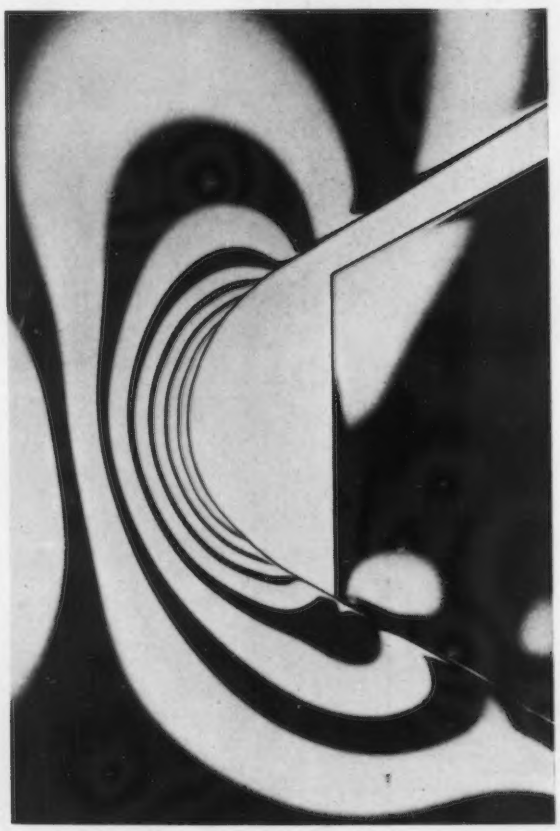
Diagram shows how void area is decreased between nut and bolt thread with new high-radius root design.

STRESS CONCENTRATIONS

Corners in flat root act as stress raisers, are breeding ground for fatigue failures.



Later design, introduced by Standard Pressed Steel makes use of larger radius, reduces stress concentrations.

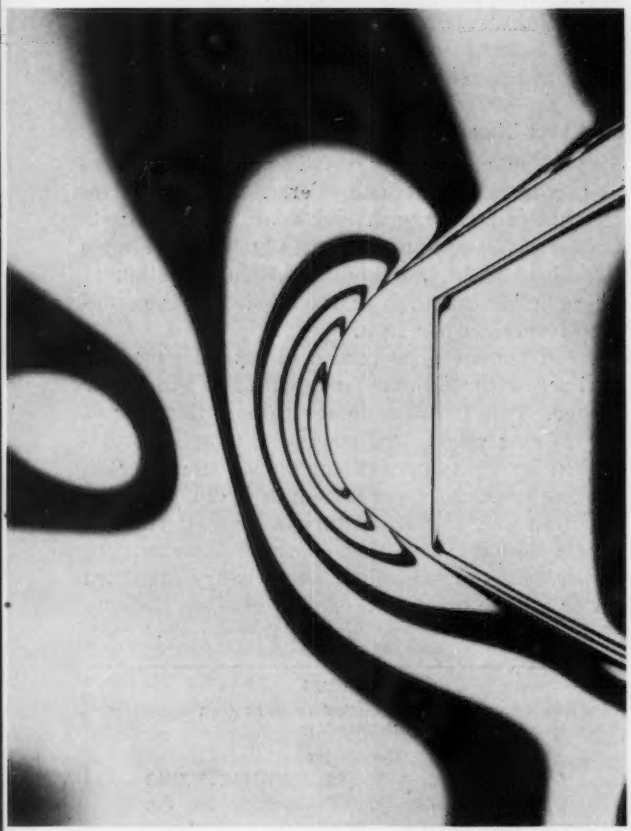


thread problem

by Thomas C. Baumgartner
supervisor development laboratory
Standard Pressed Steel Co.

IN THREAD ROOTS

Using an arced root eliminates many stress raisers. But size of radius is limited by gaging techniques.



Existing specifications for threaded fasteners allow the end vehicle to be robbed of potential reliability. Achilles heel of most bolt fasteners is the root of the thread (area of least diameter in cross section). Fatigue, and stress rupture lives can be significantly increased by using a smooth contour at the thread root. Threads with flat roots, sharp radii, and irregular contour are still allowed. This stems basically from a reluctance to change various testing methods and gages that do not adapt themselves to threads with the larger root radius.

Area of Stress

It is no secret that stresses concentrate in areas where notches exist, or where there is a large change in cross-sectional area. In normal bolt design there are two such areas:

- Head-to-shank juncture.
- Thread section.

Stress concentrations in the head-to-shank area have been reduced by the general acceptance of "generous" radial fillets in design.

The thread, in particular the root area, is designed to any shape that will fall within certain loose tolerance limits, and permit free assembly on an inspection device known as a ring gage. The basic inspection technique is the familiar Go, No-Go concept.

The gage is designed to assure free assembly of bolt with mating thread to a depth of 83 1/3 per cent of basic thread height.*

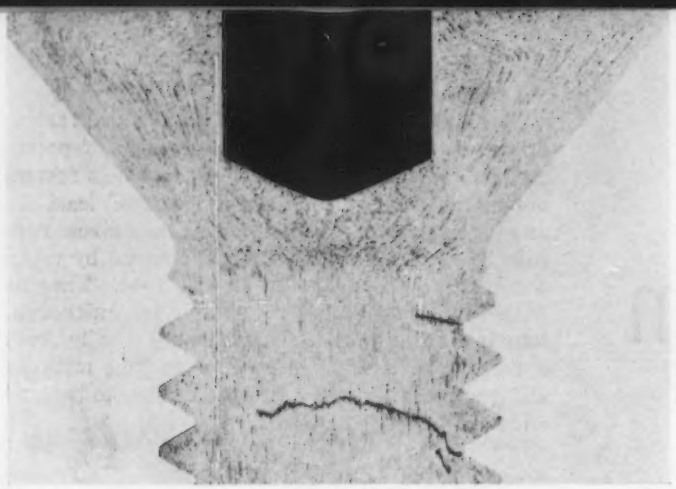
Nuts, and tapped holes are made with thread heights of only 50 to 70 per cent of the basic thread height. (Economics of production limit the depth of internal threads.) Thus, a minimum void of 13 1/3 per cent exists between mating nut and bolt threads (83 1/3 minus 70). This space could be used to add strength to the joint.

Any shape root which allows insertion of the "Go gage," and many do, is acceptable from a dimensional aspect. Hence, we have flat, sharp, and irregular thread roots.

Implications

This latitude in specification has caused some threads to fail in service while others remained intact under essentially the same loads. Loads were applied repeatedly but were well under the yield strength of the metal. There was no detectable difference in the threads using existing inspection procedures. The failures were caused by metal fatigue. Fatigue cracks start on the surface and progress inward until fracture

** Basic thread height is an arbitrary envelope with certain mathematical limits. Full definition is not warranted here. In the illustration used, it is shown as "h" and coincides with flat root contour.*



thread problem . . .

continued

Beginning of fatigue failure can be seen in flat root thread. Note how crack begins in exact location of stress concentrations in sharp corners.

INCREASE IN CROSS SECTION WITH 75% THREAD DEPTH

Size	Flat root thread area-sq in.	83 1/3% radius thread area-sq in.	Hi R thread area sq in.	Per cent Increase
1/4-28	0.0326	0.0326	0.0335	2.8
5/16-24	0.0524	0.0524	0.0539	2.9
3/8-24	0.0809	0.0809	0.0826	2.1
7/16-20	0.1090	0.1090	0.1114	2.3
1/2-20	0.1486	0.1486	0.1515	2.0
9/16-18	0.1888	0.1888	0.1924	1.9
5/8-18	0.2400	0.2400	0.2440	1.7
3/4-16	0.3513	0.3513	0.3572	1.7

occurs. Localized concentrations of stress are the breeding ground of fatigue failures. Flat, or irregular thread roots encourage rather than prevent failure.

The Obvious Solution

The obvious solution was to scrap existing gaging standards, and make a thread with a large diameter root, utilizing the void areas between the mating threads. Standard Pressed Steel has pioneered the way in doing these things. The result is a line of bolts with tensile strengths up to 260,000 psi. The new thread is known as Hi R (for high radius). Principal advantages are:

- GREATLY INCREASED FATIGUE STRENGTH. Not surprising since as little as 0.002 in. plus or minus in the root can halve the design load of a bolt or cut fatigue life from 10,000,000 to 100,000 load cycles.
- BETTER ELEVATED TEMPERATURE PERFORMANCE. The right root radius seems to be able to extend stress rupture life of parts used at 900, 1200 or 1600°F by as much as 50 to 100 per cent.
- SLIGHTLY HIGHER TENSILE VALUES. By putting more metal where it counts most, the minimum cross section area of the thread, static load carrying ability of the fastener is increased.

The Hi R root has a large, smooth, continuous radius, blending to a tangent with the flanks at the 75 per cent thread depth mark.

Radius is 25 to 30 per cent greater than that possible with the 83 1/3 per cent thread. For example, on a half-inch diam screw thread (20 threads-per-in. pitch), the minimum (low limit) Hi R radius is 0.0075 in. as compared to 0.0060 in. previously.

This "few thousandths" difference is the key to significantly improved performance.

Root Has Dimensional Tolerances

The redesigned root is an actual dimension, with clearly defined tolerances—not just an arc that can grow with tool wear. Radius limits can be expressed mathematically by the simple formula: .180p (maximum), .150p (minimum) where "p" is the pitch or one divided by the number of threads per inch.

The new type thread meets all generally used screw thread standards with but one minor change. This is in the minor thread diameter of the Go ring gage. The change is simply accomplished by grinding out the minor diameter of existing gages to a thread depth of 75 per cent.

In use, the Hi R thread mates with any female thread tapped to a depth of no more than 75 per cent—or with just about every standard nut or hole in captivity.

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With this special Linde process, you can have metals coated with tungsten carbide, aluminum oxide, and other materials to provide outstanding resistance to wear, abrasion, and fretting corrosion, even at extreme temperatures. If necessary, these coatings can be ground and lapped to one micro-inch rms or better. They consistently outlast hard chrome plating, tool steels, and in some cases, solid tungsten carbide.

When coatings of refractory metals such as pure tungsten, tantalum, molybdenum, and other ultra-high-melting-point metals are desired, Linde Company offers its new "Plasmarc" Torch service. To find out how Flame-Plating or the "Plasmarc" Torch service can solve your critical temperature and wear problems, write Dept. AMM-10 Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y.

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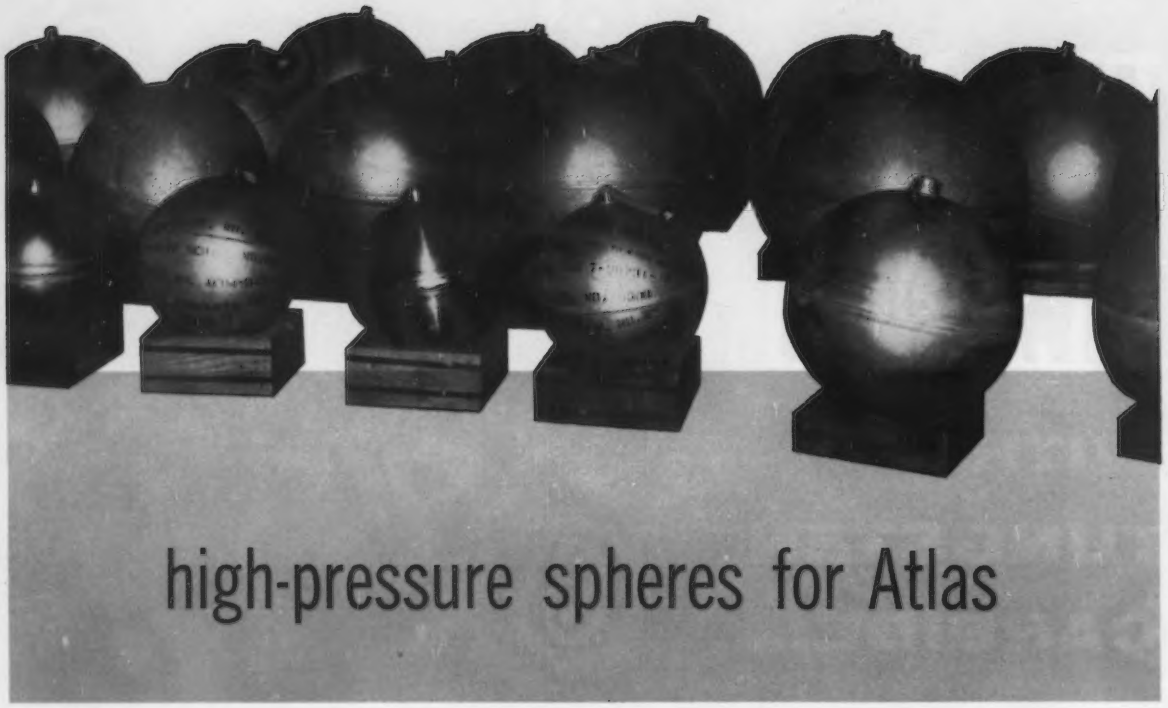


high-pressure spheres for Atlas

why Airite used "hot drawing" and 6Al, 4V titanium alloy

by Philip Geddes

The Atlas ICBM program created a need for high-pressure spheres in quantity. Specification called for low weight with high strength at very low temperatures.

Titanium seemed the most obvious material to choose. But which alloy? From research, three choices existed.

- A110AT—offered ductility (but with lower strength), and good weldability.
- Crucible's A70 Grade commercially pure titanium—offered ductile weld characteristics.
- Six per cent Al 4 per cent V alloy—could be heat treated, according to maker's specifications, but just met weldability requirements.

Test Program

Tests showed that early-published data for many titanium alloys was unreliable in predicting tensile strength of spherical applications. This was due, no doubt, to the data being based on uni-axially loaded test coupons. At that time, there was no satisfactory method of relating uni-axial test data to bi-axially loaded applications. Airite made experimental bottles from all three materials in order to determine the most suitable.

The final choice was 6 per cent Al 4 per cent V alloy (6/4). This alloy offered better strength to weight ratio and better ductility than anticipated. A fixed cost contract was then awarded by Convair-Astronautics to develop a 6/4 production bottle.

Production Method

Selection of the production method was influenced by the time limits of the Atlas program. These limitations made it essential to use known methods, or refinements of known methods, for heat treating, welding, and forming. All equipment had to be designed for maximum future use and capable of being operated by immediately available personnel. Esoteric machines

and methods were automatically ruled out.

Three methods of forming the production bottles were obvious, and equally obvious were reasons why two of these could not be used initially by Airite.

- Hot Spin—insufficient contour control, material could not be formed below 1300°F.
- Forging—at the time there was no large forging equipment available on the West Coast. (Bottles with integral bosses are now being forged, however, with good results.)
- Hot Draw—the method Airite chose.

Tooling Problems With Hot Draw

In hot drawing, the die alone is heated. Tools had to be made to allow for the expansion differences between punch and die, with all in-production dimension checks made at room temperatures. Some of the other considerations were, springback, economy, blank thickness, and lubricant.

SPRINGBACK. Titanium plate spring-back characteristics vary from plate to plate; tools were made for average spring-back value.

ECONOMY MOVE. Titanium plate is expensive. It was decided to heat the titanium blanks until they had the same tensile strength as stainless steel plate of comparable thickness. This made it possible to economize by checking the production tooling with stainless steel blanks.

BLANK THICKNESS. In deep drawing, plate thickness has considerable influence on production techniques. The thicker the plate the easier the draw; there is less wrinkling, less tearing, less springback. But, since titanium is expensive, the design had to be fixed with the thinnest possible plate at which final machining could be made.

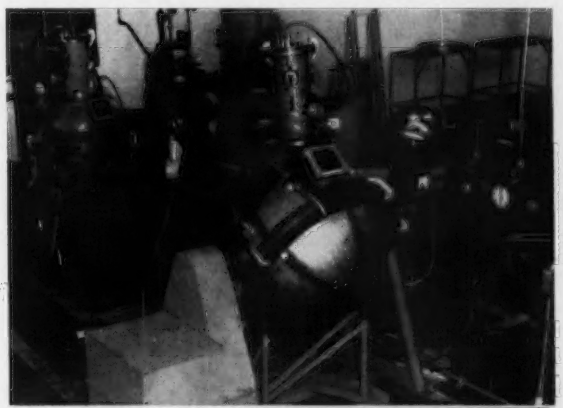
TOOLING LUBRICANT. Commercially available lubricants did not withstand high forming temperature. The company was forced to develop its own lubricant.

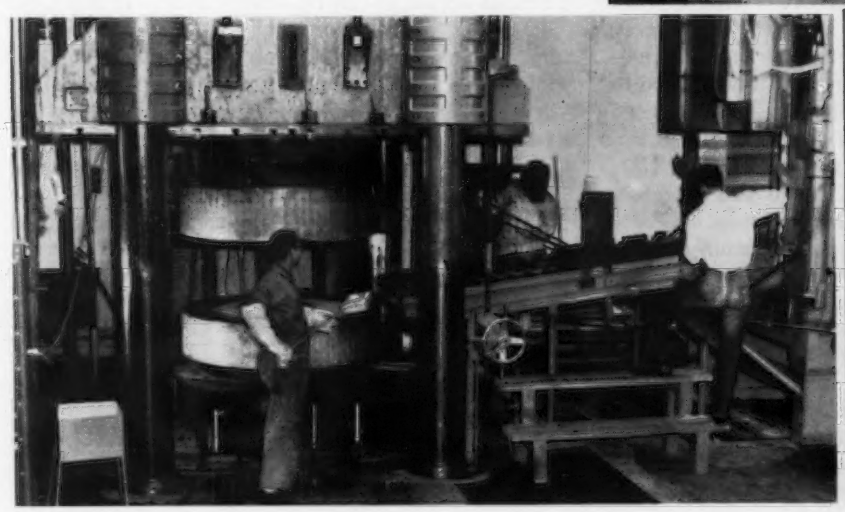
Manufacturing Sequence

Plate is purchased from Crucible Steel, with minimum thickness tolerance held between batches. Reducing thickness variations between blanks helps prevent jamming in close tolerance tooling during production. The 3/8 in. and 7/16 in. thick blanks are trimmed into a rough round shape by torch cutting. The rounding process produces an immediate 21 per cent material loss.

OXIDATION is prevented by coating blanks with ceramic coating (Turco Products, Inc.). The material is then heated to drawing temperature (1250°F) in a Lindberg electric furnace, from which it is transferred to the forming press with minimum time delay.

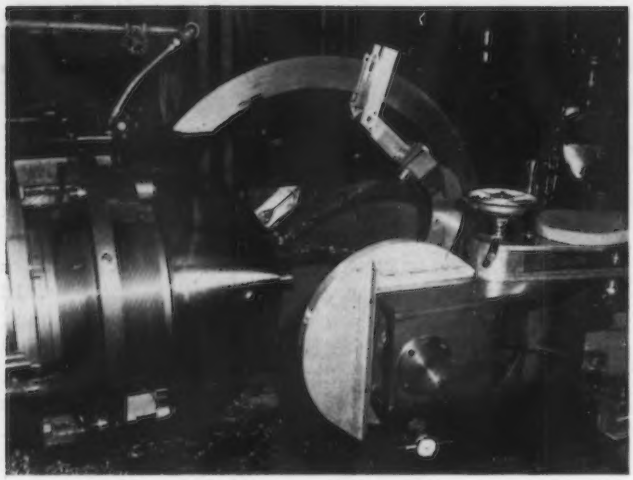
DRAWING is performed on an HPM 2500 ton press modified so that the automatic control has a manual override. Limit switches cycle the





Welding bosses to completed spheres is done in inert chamber. Sequence is automatically controlled; has manual override.

Deep draw press for forming hemispheres is located next to preheat furnace. Rollers speed handling. Ceramic coating is used to prevent oxidation.



Hemispheres are machined, inside and outside, prior to welding. Tolerance of wall thickness is ±0.005 in.

high-pressure spheres . . . continued

press through complete operation consisting of: (1) fast approach, (2) slow ram speed before contact, (3) preliminary draw speed, (4) final draw speed, (5) reverse to open. Spheres have either 21½ in. or 24½ in. diameter and are drawn to 13½ in. and 15 in. respectively.

Rough machining is performed after the draw flange is cut off each rough hemisphere and a hole is drilled for receiving the boss, which is welded in place. (Forged bottles have integral bosses.) Rough machining increases the material loss by an additional 25 per cent of the original blank weight. Finished weight shows a 70 per cent loss in raw material.

WELDING the bosses to the hemispheres is done in an inert atmosphere weld chamber. The weld sequence is automatically controlled, but the operator has manual override of all welding variables. This method eliminates undesirable contamination of weld metal. Weld joint design, atmosphere control, current, arc voltage, work speed, and rate of addition of filler metal were all determined in theory before practical application. In this way the proper weld strength for the titanium sphere application was designed into the bottles. Quality of all welds is in accordance with specification MIL-R-11468 (ORD), Standard 1. All welds are X-rayed 100 per cent.

FINISH MACHINING of hemispheres is necessary. Due to high stresses and vibration around boss areas in flight, wall thickness is varied accordingly. Rather than use a tracer lathe, bottle contour is generated by a tool, moving in a constant radius. In this way there is better tolerance control. Close quality control of the machining operation is maintained by using a specially designed automatic recording checking fixture. In five min, the operator can completely inspect a bottle and record wall thickness, inside and outside contour by making 24 scans. A minimum of one measurement per 16 sq in. of area is required. Tolerances are: wall thickness, ±0.005 in.; contour, ±0.010 in.; finish, 63 micro in. After checks are completed the two hemispheres are welded together using the same process and equipment as for the bosses. Welds are again X-rayed 100 per cent.

PRIOR TO HEAT TREAT the bottle is again covered with a ceramic protective coating. The heat treating equipment used is designed to reduce quench time to less than nine sec. Furnace temperature is controlled within ±10°F of desired temperature during both heat treat and aging process. To preclude hydrogen embrittlement, the heat treated bottles are descaled chemically by means of a multi-stage acid pickling and caustic cleaning process. After heat treatment and aging the bottles are held in a fixture and the mounting bosses line-bored and faced. Face runout across the 24 in. sphere is held to less than 0.010 in.

PROOF-PRESSURE TESTING is performed on all bottles (4,000 psig at ambient temperature and at −320°F). No permanent sets or defects are permissible at proof pressure. The bottles are then pressurized to 3,000 psig with helium, submerged in water and checked for leaks.

Cycling (0-3000 psig) tests are conducted on a lot sampling basis, the number of bottles tested decreasing as program progresses.

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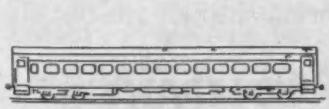

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GD30	2,500	2,500	Load & bleed valve control	400
GD31	3,600	3,600	Load & bleed valve control	600
GD61C	2,500	2,500	Load & bleed valve control	170
GD62C	3,600	3,600	Load & bleed valve control	200
GD65	6,000	6,000	Load & bleed valve control	250
GD65C	7,000	7,000	Load & bleed valve control	250
GD80A	5,000	5,000	Load & bleed valve control	500
GD81A	10,000	10,000	Load & bleed valve control	800
GD86R	10,000	10,000	For remote control only	1,200
GD100R	6,000	6,000	For remote control only	20,000
GD100	6,000	6,000	Load & bleed valve control	20,000
GD200	6,000	6,000	Load & bleed valve control	50,000
GD700	7,000	7,000	Single adjustment regulator control; self relieving	250
SR10	3,600	1,000	Small, spring loaded regulator	4
LR20B	7,000	7,000	Spring loaded regulator; self relieving	2
LR20BSS	10,000	10,000	Spring loaded; stainless steel	2
LV10	7,000	7,000	Loader valve control	15
BPR10	7,000	7,000	Back pressure regulator	2

Operating temperature range: −67°F. to +250°F.

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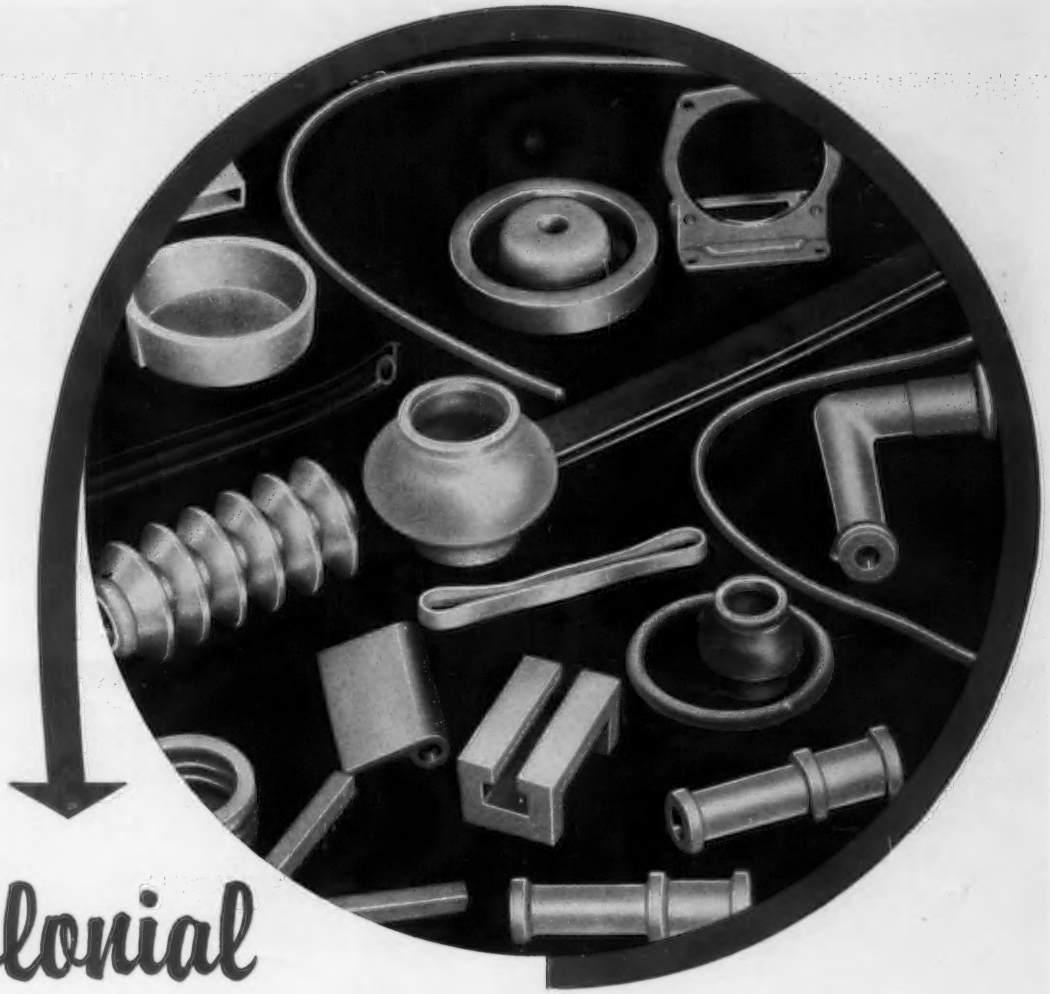

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can solve *your* SILICONE RUBBER parts problems, too . . .

Molded from various formulations of silicone rubber, these industrial rubber parts were compounded to meet the design engineer's specifications precisely. They are components of various products from home appliances to super-sonic planes, and are typical of the work we do here at Colonial Rubber Company. Check us today on your molded rubber parts requirements. We regularly compound silicone rubber parts for:

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Contains complete, illustrated details on Colonial's **custom** rubber compounding and molding service. No obligation.

1533A-1

COLONIAL RUBBER CO.
RAVENNA, OHIO

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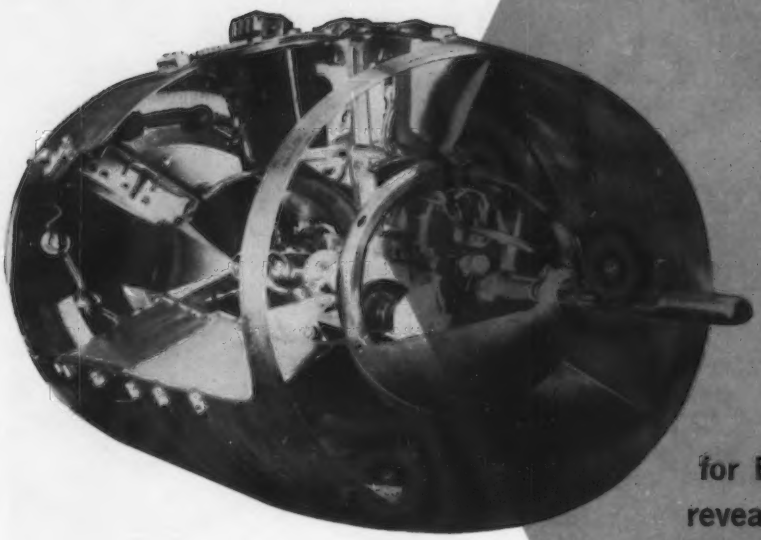
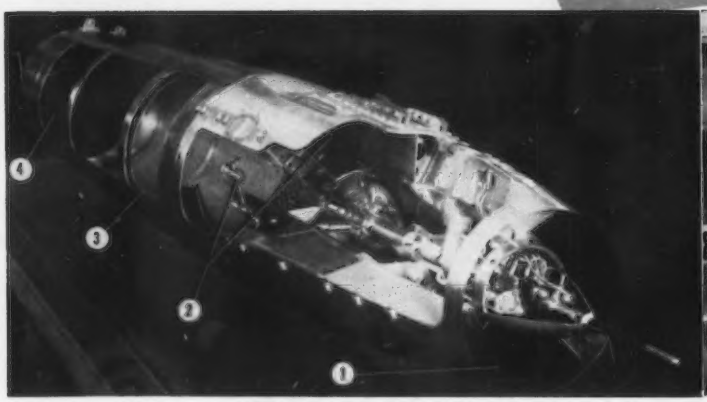
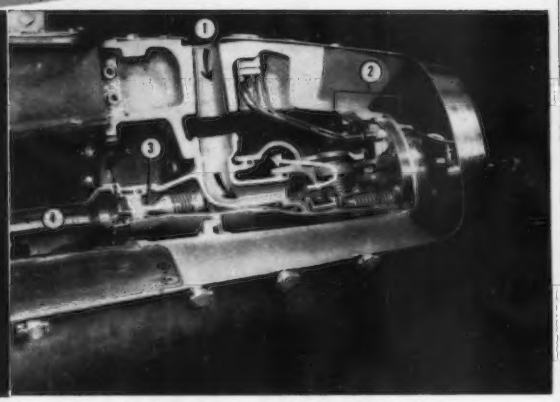
inside the ramjet



design of engine for Bloodhound missile revealed at Farnborough

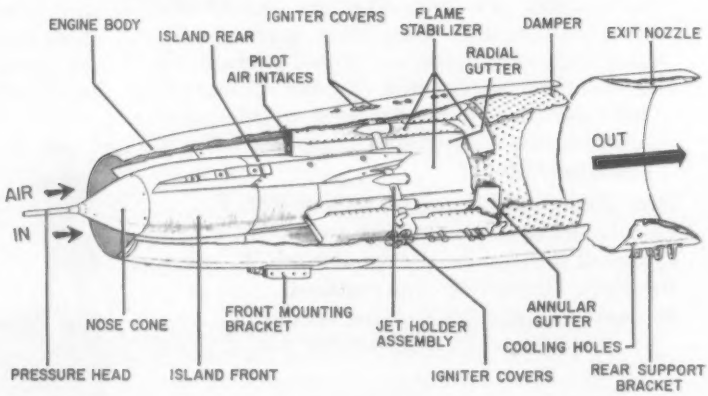


Air enters the annular intake between the nose cone and engine case at supersonic speed (1). This causes a conical shock wave to travel from nose cone to the lip of the casing. Air is slowed to subsonic speed to increase pressure. Some air enters at the pilot inlet to provide a pilot flame. Main fuel is injected through jets supported in the path of the airstream (2). Ignition is by the pilot flame. Flame is stabilized by a V-section ring gutter (removed in cutaway). The combustion chamber is surrounded by a perforated damper (3) which reduces oscillations. Vast energy released causes gases to flow out exhaust nozzle (4), producing forward thrust.



Cutaway of island within intake shows fuel-feed line (1), to air/fuel ratio controller (2). Fuel flow is then reversed back past elbow in feed line and into a check valve (3). Fuel then flows through a tube to jets (4).

Drawing shows main components of the Bristol Siddeley Thor BT-1 ramjet. Engine, which powers the Bloodhound missile, has 16-in. diam and is 8 ft long. It can develop 100,000 horsepower flying at Mach 3.



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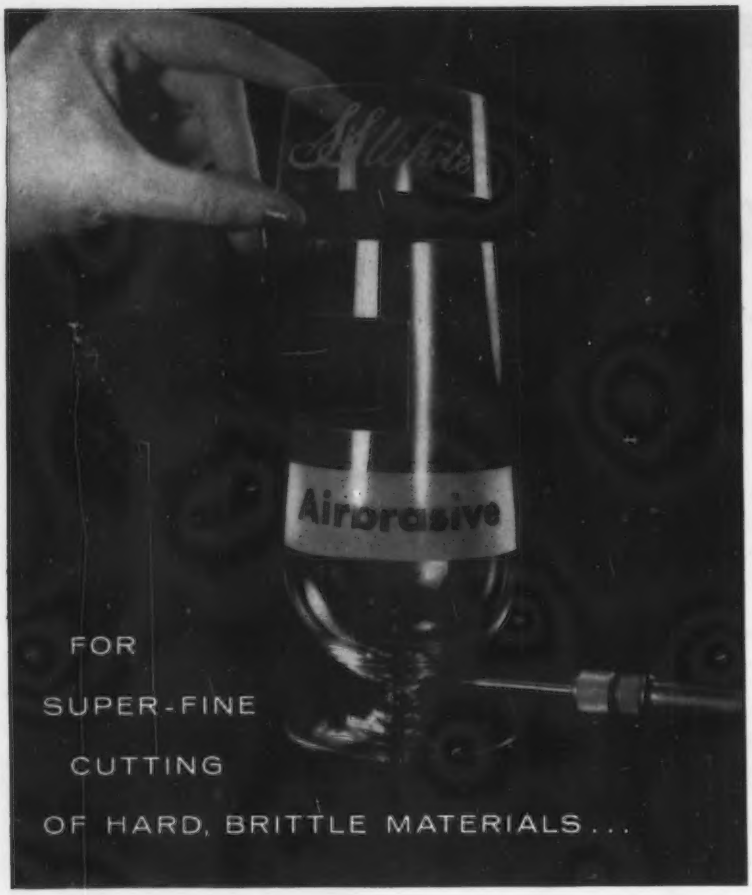

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Cuts as fine as .008" or large frosted areas are equally easy to make with this amazing industrial tool. A gas-propelled stream of abrasive particles quickly slices or abrades, as needed, almost any hard, brittle material, such as fragile crystals, glass, oxides, metal, minerals, ceramics.

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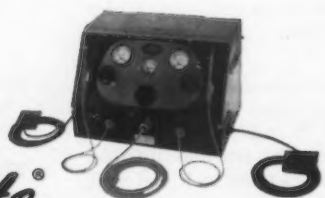

New dual Model D1

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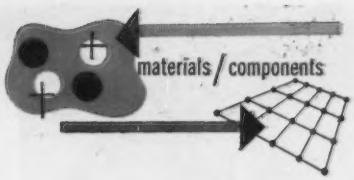


MOTOR GENERATOR WEIGHS ONE OUNCE

Size 5 motor generator—smallest in the servomechanism field—is being produced. Weight, including leads, is 1.0 oz., less than half that of size 8 MG.

In designs for future missile production, miniaturized MG means reduced power requirements, smaller Servo amplifiers, smaller temp rise. It develops stall torque of 0.10 in. oz, no-load speed of 10,000 rpm, maximum null voltage of 12 mv. A new manufacturing system, with some patented techniques, allowed the reduction.

Daystrom Transicoil
Div. of Daystrom Inc.

Circle 76 on postcard for more data

INTRICATE SHAPES OF EXTRUDED TEFLON

Shown are a few of the "custom made" Teflon extrusions produced by Pennsylvania Fluorocarbon Co., Inc.

Dies are designed to customer specifications for the end

product. Allowance is made for thermal expansion and contraction both in manufacture and in service for operating temperatures up to 250°C. Extrusions, which can be sliced as short as 0.030 in., claim a saving over machining from rod, tube or flat stock and eliminate machining waste which might otherwise run as high as 80 per cent of the original material.

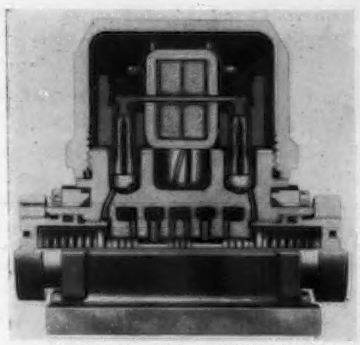
Duffin-Hughes Assoc.

Circle 75 on postcard for more data

SHROUDED SERVO VALVE NOZZLE CUTS CONTAMINATION FAILURES

A shrouded nozzle servo valve reduces possibility of first stage malfunction in missiles because of oil contaminants.

The design retains the



superior response and temperature stability advantages of wet coil configurations. It eliminates their possible contamination problems, however, by channeling the oil away from the torque motor.

The nozzles are surrounded by a concentric outer shroud, and nozzle flow is returned through the passage between the shroud and the nozzle itself. Since there is no return passage from the torque motor chamber, all nozzle flow must return in this manner after the chamber is originally filled.

Bendix-Pacific Div.
Bendix Aviation Corp.

Circle 78 on postcard for more data

CERAMIC BONDED TO SAPPHIRE

Ceramic-to-sapphire seals are now made possible by high temperature non-metallic bonding technique.

continued on next page

CURTISS-WRIGHT

THERMOCHROM

Here's a foolproof way to check temperatures during welding or heat-treating operations . . . use new Thermochrom temperature-indicating color crayons.

Measurement of temperatures at stages between 150° and 1240° F. is possible with the different crayons in the Thermochrom family. Each crayon's wrapper shows its point-of-change temperature and the color that results. This color change does not "melt away" but gives a permanent record of the temperature reached, making it simple for anyone to check welding temperatures at a later time. Every Thermochrom crayon is usable to its full length. Priced at only $2.00 a crayon.

Use Thermochrom to solve your "heat checking" problems. For further information regarding where to buy and how to use Thermochrom, write to:

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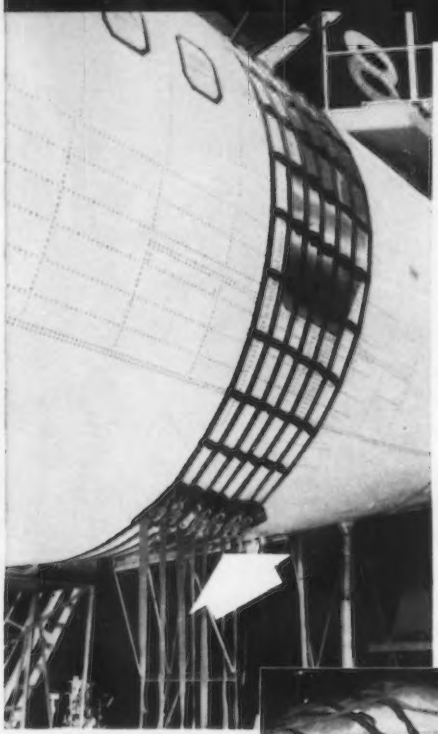
Convair 880 Utilizes Dependable Aeroquip Nets and Ratchet Buckles for Cabin Pressure Tests



AEROQUIP WEB NETS AND RATCHET BUCKLES SOLVE MANY FABRICATION PROBLEMS

At Convair Division of General Dynamics in San Diego, Aeroquip net harness systems are used in the production of the sleek new jet-powered 880. The special web nets are quickly tensioned on each new fuselage to protect personnel during cabin pressure tests. After testing, the nets are removed and reused on the next fuselage.

Whatever the operation, if you have to position or protect structural pieces in fabrication, you can do it better with Aeroquip nets or straps, and Aeroquip Ratchet Buckles. Mail the coupon below for full details.

Fuselage doors are protected with girdled net, securely tensioned with Aeroquip Ratchet Buckles (arrow).

Cockpit at right is protected with a specially made web harness, held in position with Ratchet Buckle straps.

Aeroquip

REG. TRADEMARK

GENERAL LOGISTICS DIVISION
2929 FLOYD STREET, BURBANK, CALIFORNIA AMM-10

Please send full details on Aeroquip Web Nets and Ratchet Buckles

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Company_____

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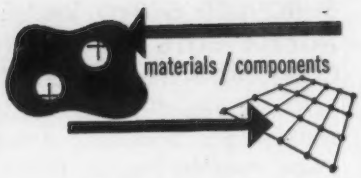

Excellent transmission of sapphire is useful for windows in infrared or microwave absorption cells. Seals are also useful as entrance and exit windows for optical systems that require a strong, vacuum-tight, chemically inert, high temperature resistant material. The similarity of the ceramic body (Alite) to pure sapphire is evidenced by the fact that both materials have virtually the same dielectric constant, loss factor, coefficient of expansion, and other high performance characteristics.

Alite Div.
U. S. Stoneware

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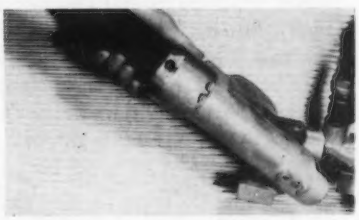
QUICK CONNECTOR FOR COMPRESSED AIR

A simply installed and removed connector for feeding compressed air to aircraft is now universally available.



With this connector the hose is always charged. The operator merely inserts the connector probe into the airplane receptacle. As soon as the engines are started the operator disengages the coupling with a simple tug on the hose. It falls freely to the ground, completing the operation.

It safely handles pressures up to 4000 psi. Burst pressure is around 20,000 psi minimum.

Mechanism is designed to be dust and dirt proof, but a cover gives added protection.

Besler Corp.

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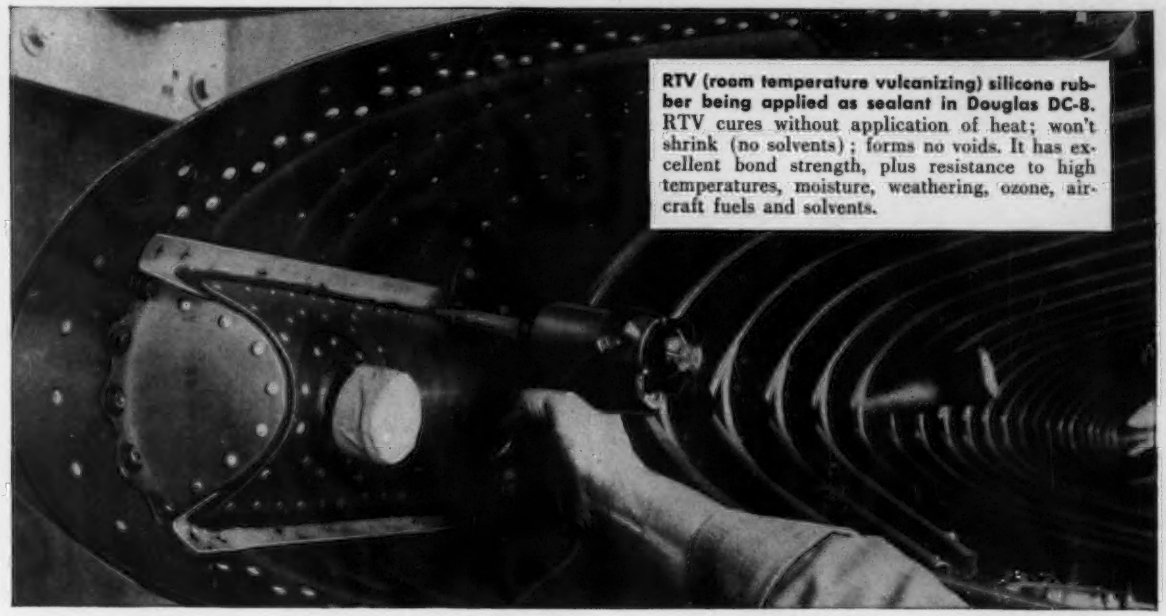
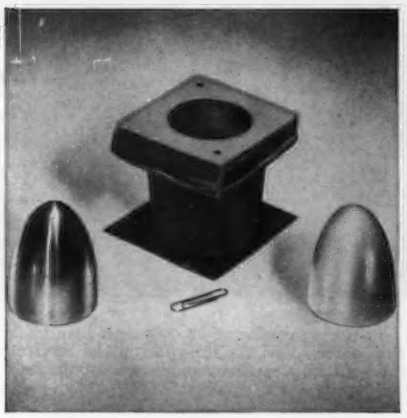


RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.

Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from −60°F to +600°F; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section BB102, Waterford, N. Y.

GENERAL ELECTRIC

Silicone Products Dept., Waterford, N. Y.

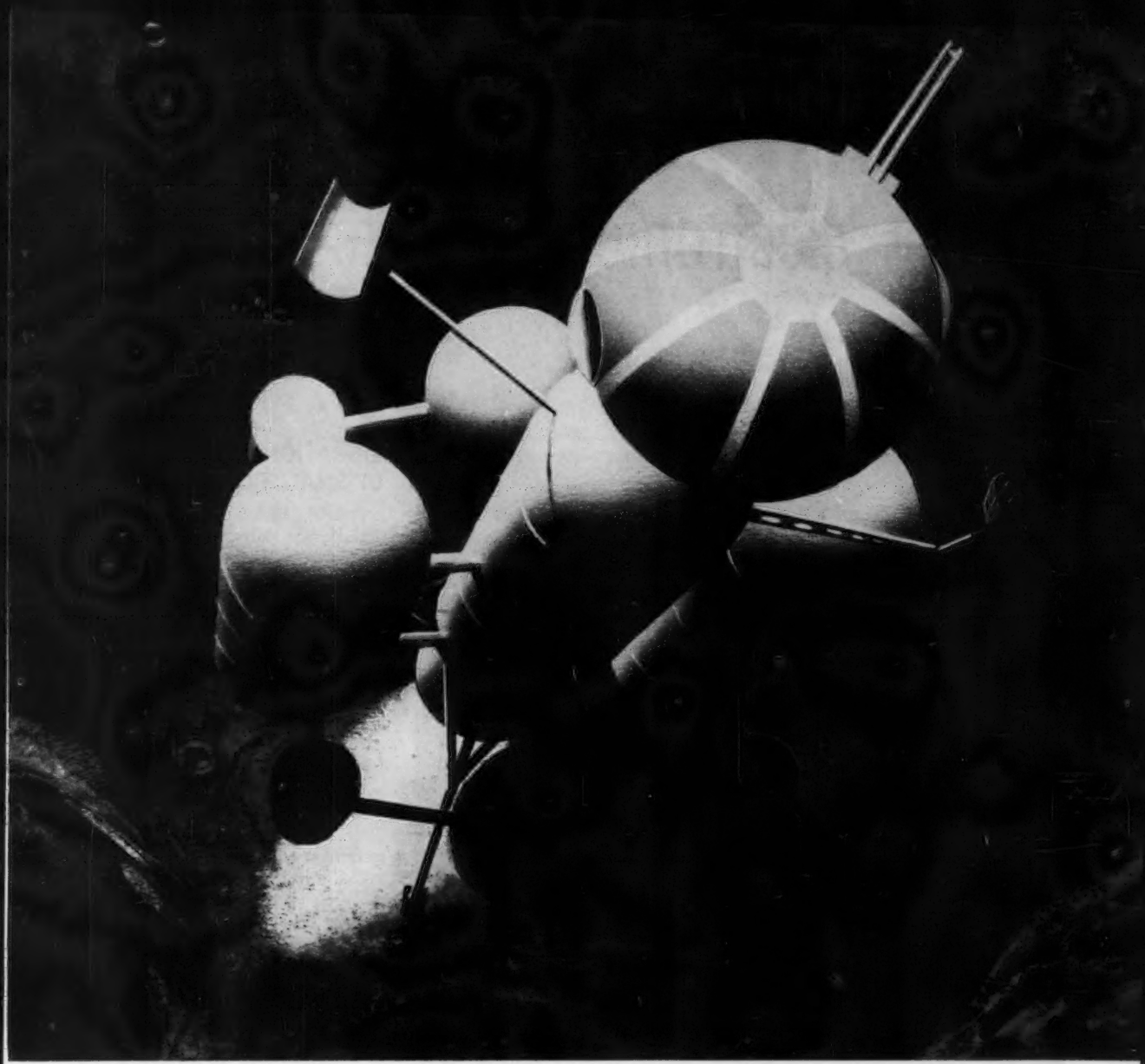
This scientific pioneer is our Dr. G. K. Wehner, designer of the "space chamber" which he uses here to determine the "sputtering" or disintegration rate of molybdenum under bombardment from atoms moving at 25,000 mph hundreds of miles above the earth. His studies can have bearing on materials which will be used in future space vehicles.

General Mills scientists are helping today to

The Mechanical Division of General Mills is contributing to man's knowledge of space through work in the vast field of geophysics. Important effort is directed toward increased knowledge of space phenomena vital to the future of space travel.

Our research activities cover broad areas in physics, chemistry, mechanics, electronics and mathematics. Some of the studies representative of these activities are: ions in vacuum, deuterium sputtering, dust erosion, magnetic materials, stress measurements, surface friction and phenomena, trajectory data and infrared surveillance.

In our engineering department, current projects include: airborne early warning systems, micro wave radar test equipment, antennas and pedestals, infrared and optics, inertial



man reaches the moon . . . illustration from a book written for General Mills by Willy Ley.

pave the way for tomorrow's trip to the moon

guidance and navigation, digital computers.

Our entire manufacturing department is geared to produce systems, sub-systems and assemblies to the most stringent military requirements. Our people have a wealth of experience in complex military projects.

We will be happy to discuss with you the many ways in which our research, engineering and manufacturing capabilities can serve you. Write for more information.

MECHANICAL DIVISION
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To wider worlds—through Intensive Research • Creative Engineering • Precision Manufacturing

General Mills

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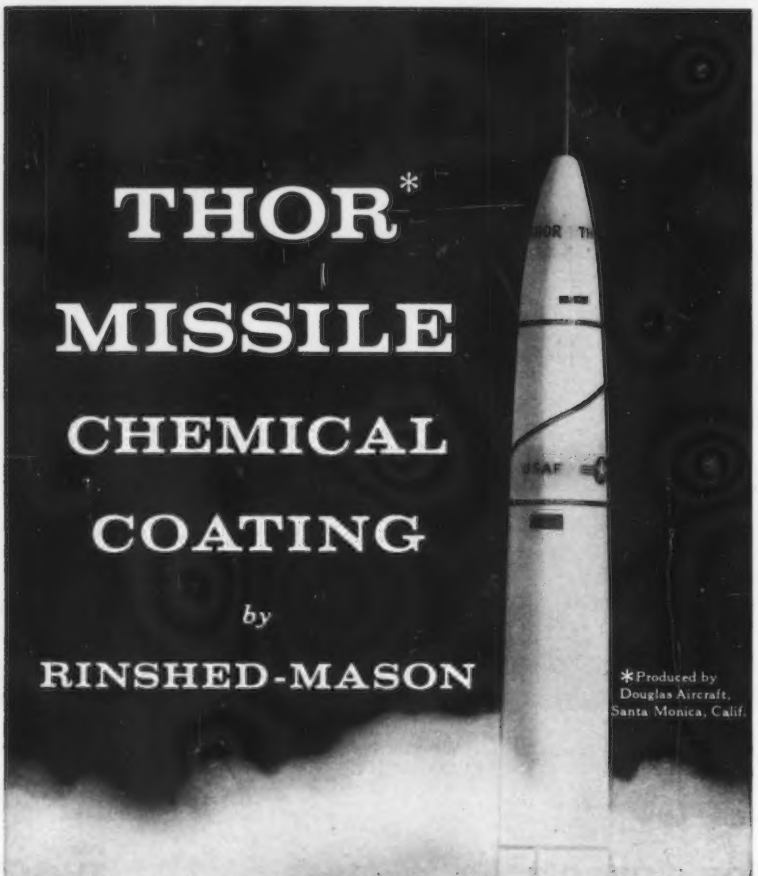
electronic products



The Rinshed-Mason chemical coating covering the THOR* missile will tolerate temperatures upwards of 550°F. at the rate of 10°F. per second temperature rise. Air dries to a high gloss in less than 30 minutes. Excellent salt-spray and humidity resistance. Available in White (Q51W807), Blue (Q51B813), Red (Q51R806), and Black (Q51K806). Rinshed-Mason maintains extensive research and production facilities for special finishes and chemical coatings for aircraft, missiles, and space craft.

R-M

RINSHED-MASON COMPANY, INC.

Detroit 10, Michigan • Anaheim, California • Windsor, Ont., Canada

VIBRATION TESTING OF SMALL COMPONENTS

A new 70 pounds-force sine wave vibration system is designed for environmental vibration testing of small components and systems.

The new system consists of a Ling Model RA-250 power generator driving a Ling Model 227 electro-dynamic shaker. The same generator can also be used to drive an acoustic vibration system.

All power generator components, including an Altec 260A amplifier and a Ling field supply and manual oscillator, are housed in a compact metal cabinet with a "slope" front for easy access to controls. The cabinet is 2 ft. wide, 2 ft. deep and approximately 4 ft. high.

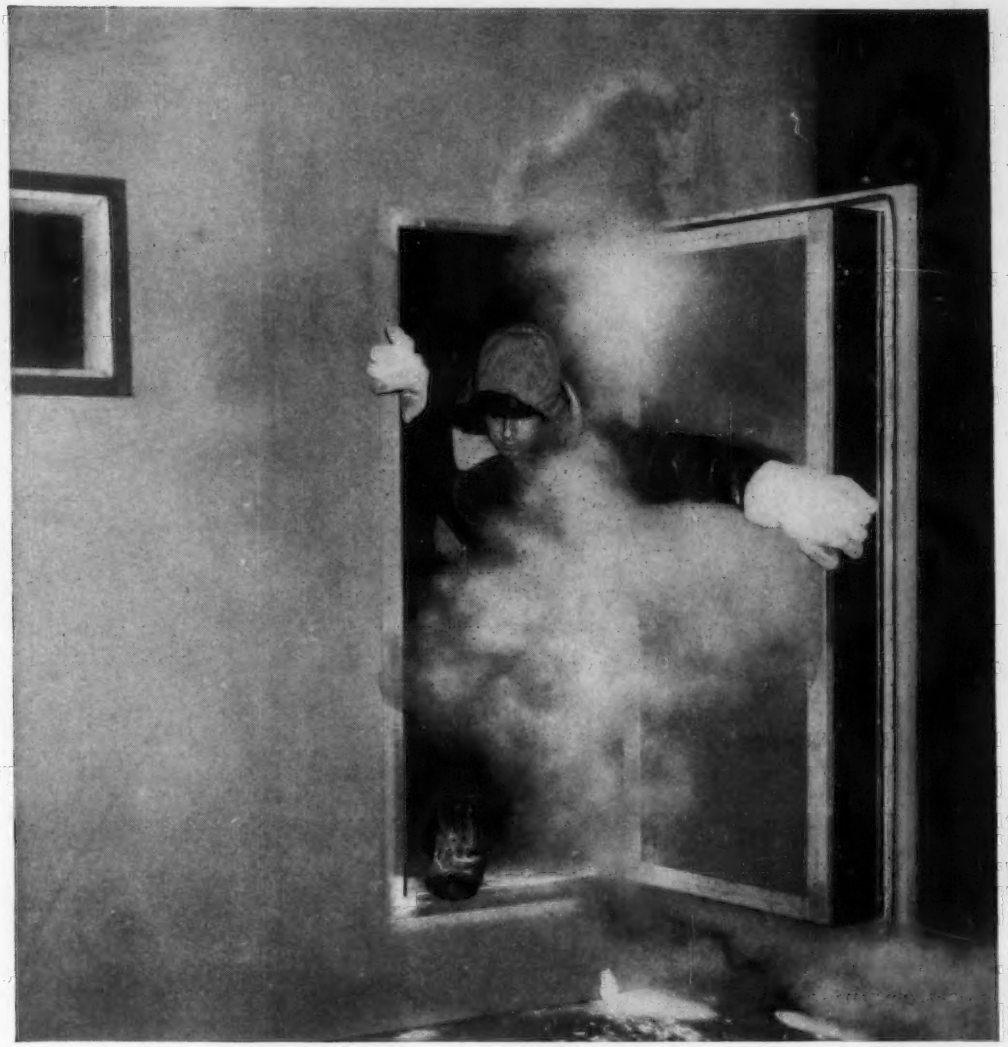
The new 70 pounds-force system provides continuous operation over an extended frequency range of 5 to 2,000 cps. No impedance changing or manual power factor correction is required over this full frequency range.

Wide-band shaker has a maximum output of 150 pounds-force. Maximum rigidity allows a high first resonance of approximately 9,000 cps bare table. The shaker is approximately 1½ ft. by 1½ ft. at the base, with a height of 2 ft.

Ling Electronics Inc.

Circle 73 on postcard for more data

continued on page 45



Partial view of a 10' x 10' x 35' low temperature test chamber built by the Mantec Division of Wyle Manufacturing Corp., El Segundo, California. Bulk liquid PURECO CO_2 can bring the interior down to —110° F. in minutes.

PURECO CO_2 puts the *freeze* on Wyle test chambers

Inside this low temperature chamber at Wyle Laboratories, missile and aircraft mobile ground support test units are subjected to temperatures plunging well below arctic fare.

The best refrigerant for this important test job is PURECO CO_2 in bulk liquid or solid form ("DRY-ICE"). It can be ACCURATELY CONTROLLED, is MAINTENANCE-FREE, CONVENIENT, RELIABLE and LOW IN COST.

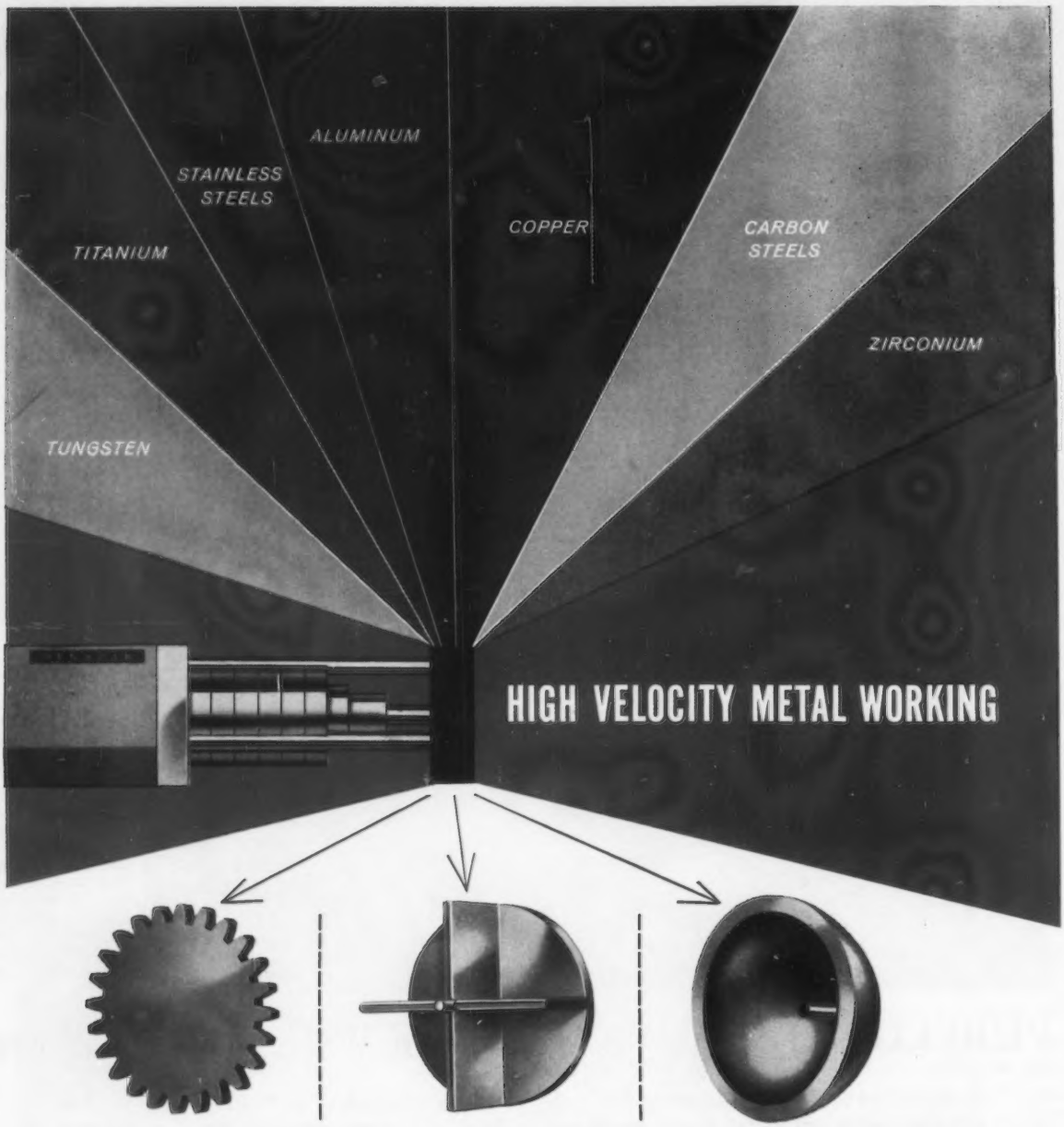
Wyle standardizes on PURECO CO_2 because PURECO means *dependability of supply* and know-how.

PURECO'S Technical Sales Service is qualified to assist you in adapting CO_2 to any particular refrigeration or inerting application. Call your PURE CARBONIC representative. There are more than 100 PURECO locations from coast to coast.

PURECO CO_2

Pure Carbonic Company

A Division of Air Reduction Company, Incorporated
150 EAST 42ND STREET, NEW YORK 17, N. Y.



DYNAPAK—A NEW DIMENSION IN DESIGN AND PRODUCTION OF METAL PARTS

The ability of DYNAPAK high velocity metal working machine tools to forge, form or extrude intricate shapes to precision tolerances from common or high strength metals, offers new solutions for complex problems of design and manufacture.

THE DESIGN ENGINEER will find a new degree of freedom in design. He is no longer confined by the limitations of conventional forming techniques. He can now more nearly specify the ideal materials, shapes, and tolerances.

THE PRODUCTION ENGINEER can often accomplish, in a single operation and with simplified tooling, what would otherwise require multiple operations and complex tooling. With DYNAPAK, management can realize a substantial long-term advantage in capital investment.

Arrange today to evaluate DYNAPAK for your metal working operations. Write, wire or phone

DYNAPAK

CONVAIR / A DIVISION OF GENERAL DYNAMICS CORPORATION

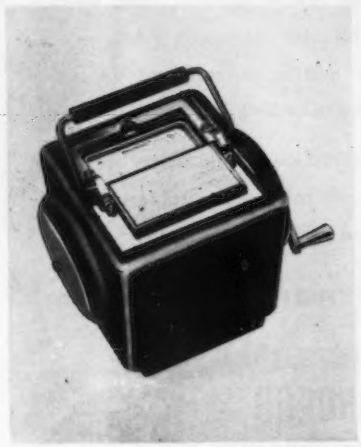
1243 Transit Avenue, Pomona, California • Telephone: NAtional 3-1561

MODERNIZED MEGOHMMETER

Series B Megohmmeter is announced as the first basic improvement in hand-crank megohmmeter design in 25 years.

Modernized version of the well known ratio-coil style features six basic design improvements:

▸ A generator with a 39-bar armature replaces conventional 2-bar or 4-bar unit. This assures that resistance measurements are made at a reliable constant value of voltage. ASTM



standard resistance tests are made at a specified constant 500 volts, not at a peak of 707 volts. Peak-to-average ratio is less than 1.09 to 1. Generator output current rating is five times that of previous models.

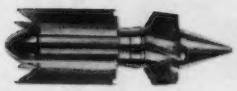
▸ Generator armature windings are skewed to prevent "slot lock" for operating ease. Gear train driving the generator is mounted on needle bearings.

▸ Neon lamps illuminate the meter dial, stabilize generator output against random "leakage bursts."

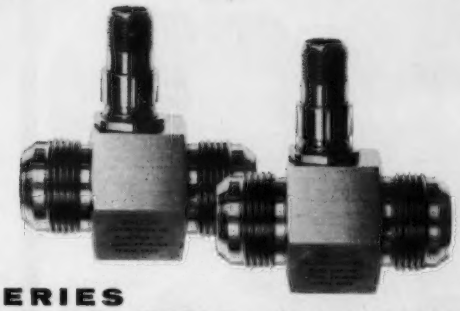
▸ Fast charge and discharge switch gives rapid circuit measurements.

continued on page 50

Waugh FLOW SENSORS . . .



a significant advance in flow instrumentation



FF SERIES FLUID BEARING

FB SERIES BALL BEARING

The new Waugh FF and FB Series flow sensors are an outgrowth of more than 25 years experience in the design and production of flow instrumentation. Completely new, yet proven through strenuous testing in actual use, these flow sensors have almost universal application and are the basis for our standard flow instrumentation line.

Both models feature extremely high accuracy, linearity and *infinite* life in use. Decreased bearing drag aids to linearity and practically eliminates maintenance problems.

The turbine rotor of the FF sensor floats entirely on a filtered film of the liquid being measured, obviating wear from either radial or thrust friction. The FB turbine is supported by two ball bearings, which are lubricated and scavenged by the fluid in the line.

FLUIDS — Meters hydraulic oils, cryogenics, corrosive fluids, jet-aircraft fuels, and many other difficult to handle fluids.

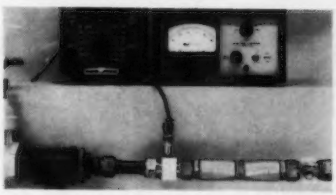
LINEARITY — ± ¼%.

REPEATABILITY — The absence of conventional bearing surfaces results in reproducability within 0.1% of flow rate.

EXPECTED LIFE — Infinite.

SIZES and FLOW RANGES — Standard ranges are from 2 to 500 GPM, in sizes from ⅜" to 2¼" line o.d. The FB series is available also in ½" line o.d. model with flow range from 1 GPM. Standard models available in bulkhead length. Other sizes and ranges are available.

LINE PRESSURE — Standard stainless steel unit is suitable for 5000 psi, with higher pressure ratings available.



This FF Series sensor has been operating **continuously** at 35 GPM for 4357 hours to date, and is still functioning perfectly. Expectancy unlimited!

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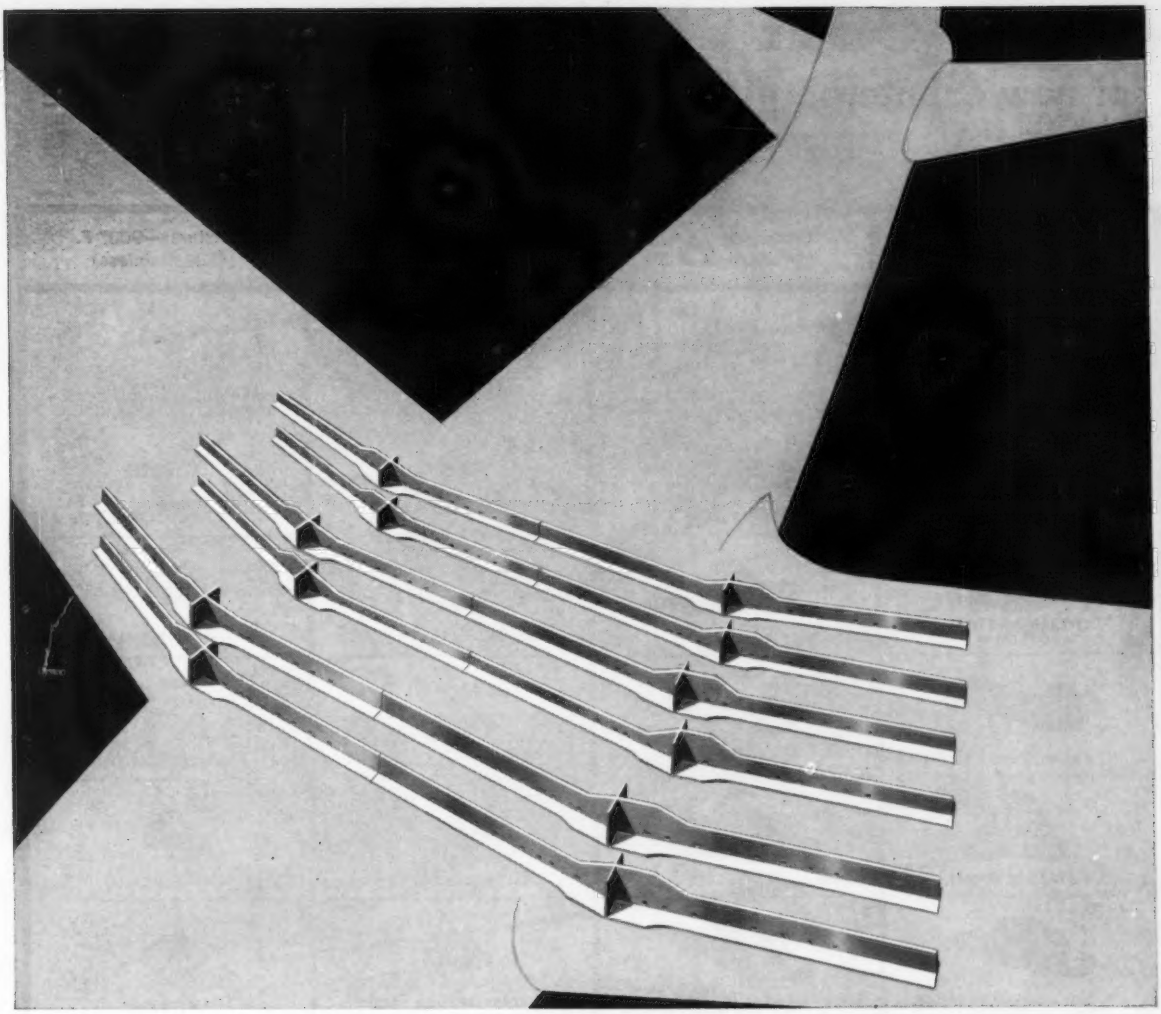


420 pounds of Alcoa Aluminum spar caps support 143-ton payloaded Douglas DC-8

Twelve aluminum spar caps are an integral part of the torque box that joins wing to fuselage and carries the entire 143-ton wing loading of the Douglas DC-8 Jetliner. Forged-in toughness of these caps is imparted under the pressure of Alcoa's 50,000-ton hydraulic press at Cleveland, Ohio. Weighing 294 lb each, the forged caps are machined and finished by Utility Metal Products, Div., Young Spring & Wire Corp., Pasadena, Calif. The caps are typical of the many complex structural parts for aircraft produced by Utility.

At Utility, 88 per cent of the metal disappears, a 35-lb gleaming wing spar emerges. This lightweight muscle and 11 others similar in configuration must not only carry a loaded plane in the air, but bear violent, repeated stresses of take-off and landing. It must also set sweepback of wing and dihedral angle.

When 90 per cent machined, spar caps are sent to Douglas, anodized and heat treated. Final straightening is followed by finish machining at Utility. All surfaces are handscraped to a 35 microfinish, each piece requiring 22 man-hours. Back at Douglas, caps are aged, again anodized, painted.

Here is just one example of Alcoa® Aluminum that leads a tortured life not only in the air, but in the machine shop beforehand. This caliber of performance means that the quality of the aluminum must be uniform in every ounce of the original forging, the original toughness retained in every linear inch of the finished cap. And it is . . . in Alcoa Aluminum. These are universal reasons for the choice of Alcoa Aluminum in difficult, demanding fabrications.

How can you use Alcoa Aluminum profitably? Find out. Contact our sales office or write Aluminum Company of America, 2032-K Alcoa Building, Pittsburgh 19, Pa.

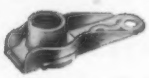
ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

SELECTION CHART

of new counterbored, low height, standard and miniature ESNA/NAS self-locking nuts

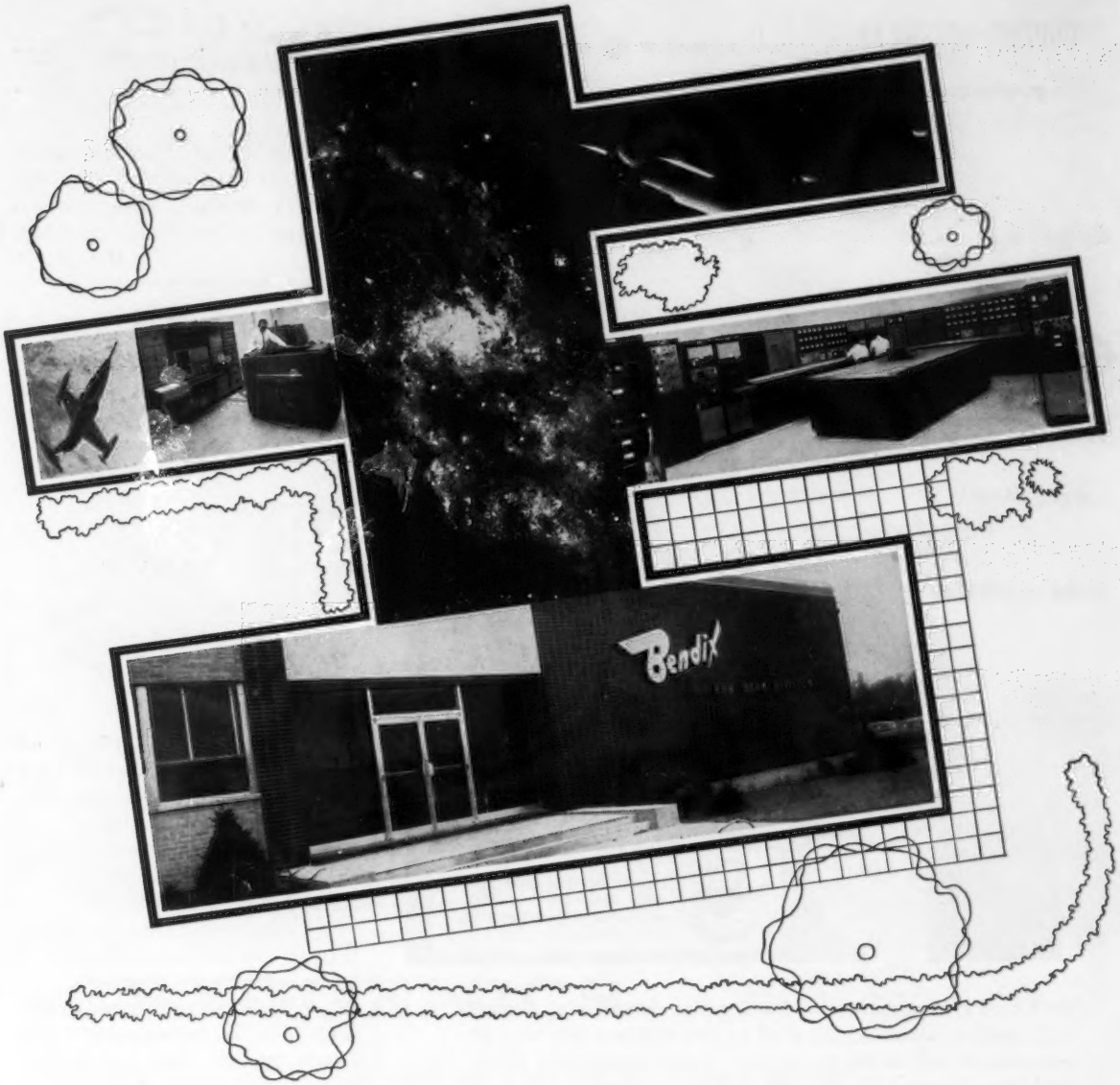
Standard—550° F. (Carbon Steels)	Standard—900° F. (A286 Stainless)	Miniatures—550° F. (Carbon Steels)	Miniatures—900° F. (A286 Stainless)
LHTE (NAS 679)	LHTE2860	LH1660	79LH1660 (303 Stainless)
LHTA51 (NAS 680)	LHTA51-2860	LHTA51M (NAS 697)	LHTA51M2860
LHTA58 (NAS 681) 100° Ctsk	LHTA58-2860 100° Ctsk	LHTA575M (NAS 1067)	LHTA575M2860
LHTA57 (NAS 682)	LHTA57-2860	LHTA57M (NAS 696)	LHTA57M2860
LHTA55 (NAS 684)	LHTA55-2860	LHTA55M (NAS 698)	LHTA55M2860
LHTA521 (NAS 686)	LHTA521-2860	LHTA521M (NAS 1068)	LHTA3300
LHTA517 (NAS 687)	 LHTA517-2860	LHHA3575	
LHTG51 (NAS 688-92)	LHTG51-2860		
LHTA54 (NAS 683) 100° Ctsk			
LHTA35 (NAS 685) 100° Ctsk			
LHTG55 (NAS 693-5) 100° Ctsk			

To meet the requirements of the aircraft, missile and avionic industries for lighter-weight, reduced-dimension fasteners for elevated temperature service, ESNA has designed and is *currently producing* all of these new self-locking nuts. Every part conforms to NAS specifications and the entire line has full Military Services approval.

This is just a part of the *complete line* of self-locking Elastic Stop® nuts which only ESNA offers as standard parts, including AN 362, 363, 364, 365 and 366 types; also special designs such as high tensile, barrel and self-aligning fasteners, all types of straight and radius gang channels and very high temperature all-metal slotted beam designs for use on jet engine applications at temperatures in a range of 1200°F.

For free copy of ESNA/NAS conversion table containing both NAS drawings and ESNA equivalents with full details, write Dept. S12-1098 Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, N. J.

ELASTIC STOP NUT CORPORATION OF AMERICA



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the solid Shim that p-e-e-l-s for adjustment

Laminum looks, acts like solid metal—yet quickly p-e-e-l-s to precision fit right at the job. In Brass, Mild Steel, Type 302 Stainless with .003" or .002" laminations. In Aluminum with .003" laminations or NEW with .002" laminations. Custom-made, Laminum Shims eliminate extra operations: no machining, no grinding, no stacking, no miking. *And no grit between layers—ever!*

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electronic products

▸ Recessed terminals eliminate cracked binding posts.
▸ Non-skid base prevents slipping during crank operation.

The Winslow Co.

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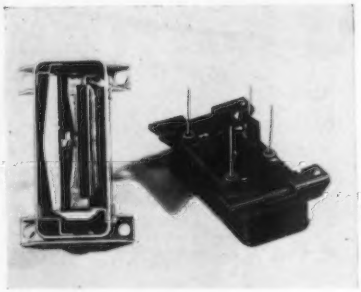
THERMAL TIME-DELAYS DESIGNED FOR MISSILES

Type PT Thermal Time Delay is designed to operate



under vibration of 2000 cps at 20 g and under shock of 50 g for 11 ms. There is no resonance below 2000 cps and extended exposure to these conditions is said to cause no damage or change in characteristics.

Operating time delays of 3 to 60 sec are available with a tolerance of ±5 percent.

Delays are hermetically sealed in a rectangular case. Leads project thru the bottom of the case and are located on 0.2 in. grid spacing for convenience in use with printed circuits. Weight is 2 to 2¼ oz.

G-V Controls Inc.

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INDICATES PHASE SEQUENCE

Portable instrument indicates phase sequence in three-phase power systems.

Model 40, for 60 c. power, has a switch for adjusting to 120, 240, and 480 v: It is pocket size (3 in. x 5 in. x 2 in. without moving parts or batteries).

Associated Research Inc.

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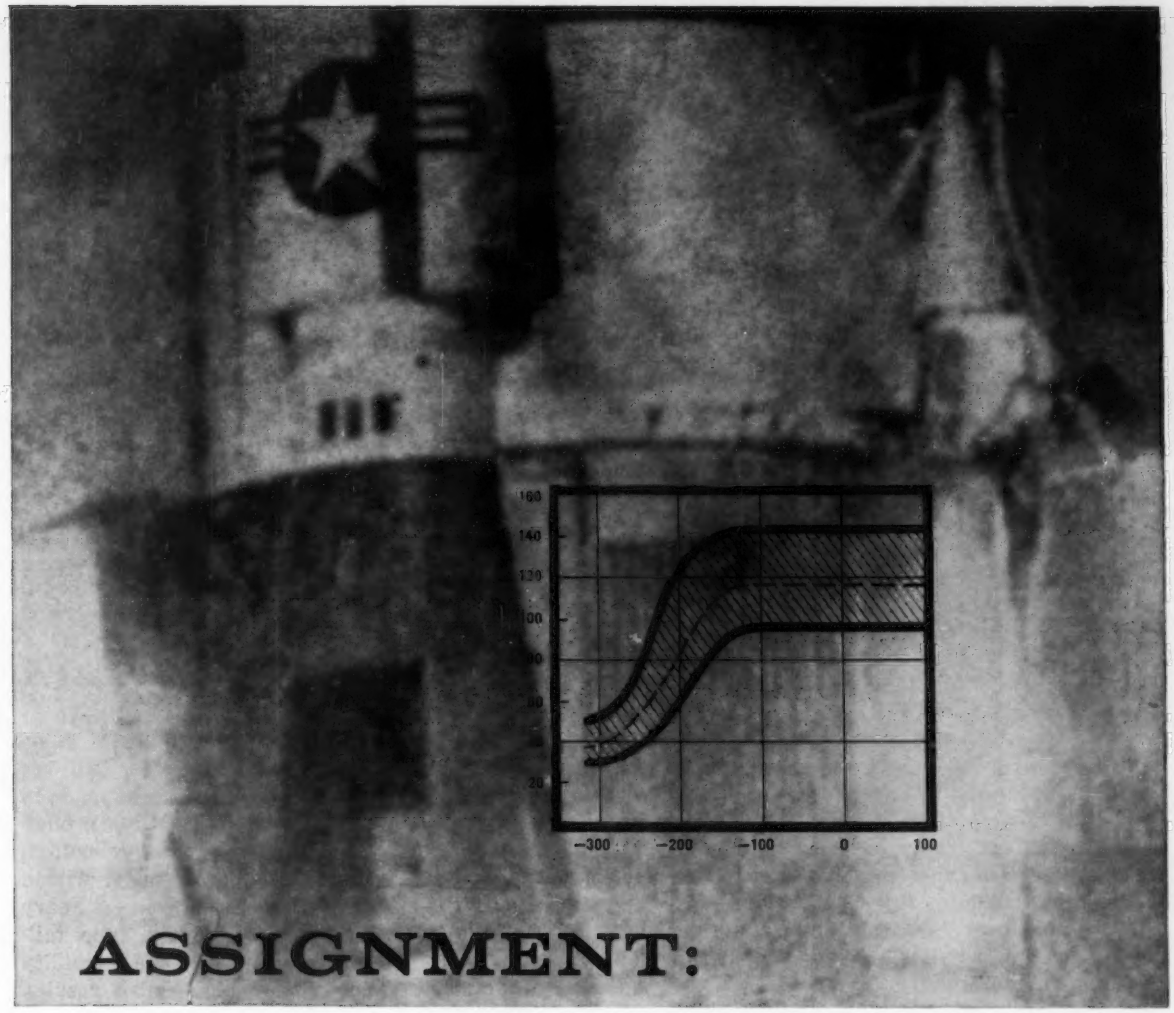


ASSIGNMENT:

CRYOGENICS

How Lukens *Application Research* helps you find the right steel plate for the job

If your assignment is designing equipment for extreme low temperature service—our Application Engineering staff can help you. They research problems of every description from the design stage right through to how the equipment has performed for years after its installation.

Missile components and liquefied gas tanks would be dangerously susceptible to cracking if made from ordinary steel. Seeking economical metals for such applications, Lukens engineers began years ago to watch the performance of nickel bearing alloys in a variety of low temperature equipment. Result: a broad understanding of metal behavior at various low temperature levels.

Examples: In the storage of liquefied oxygen, a tank of *Nine Nickel steel* provided more than eight years of trouble-free performance. Suitable to minus 320°F. service the steel showed no signs of cracking when removed for inspection. In frigid chambers for testing high altitude aircraft, *2½ percent nickel steel* is standing up well under pressures as high as 7,000,000 pounds. And in arctic locomotives operating at temperatures to minus 50°F. on rugged mountain roadbeds, main structures of *Lukens "T-1" Steel* have required no maintenance whatsoever.

Lukens Application Engineers know these cases . . . plus many more. *If your assignment is cryogenics, why not let it be our assignment, too?* Contact Manager, Application Engineering, L109 Services Building, Lukens Steel Co., Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

LUKENS

ASK FOR LUKENS NINE NICKEL STEEL BULLETIN

LATHE GIVES CRITICAL MICROINCH FINISH

Series 62 lathe is designed to finish turn rolls, cylinders, tubes to critical microinch finish at surface speeds above 2000 sfpm. Taper is held within 0.00025 in., concentricity to less than 0.0005 in.

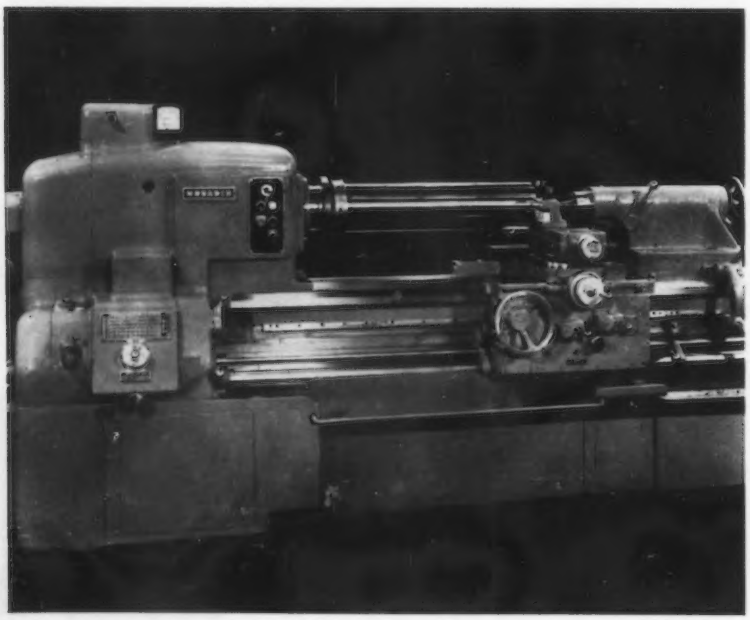
Swing over bed ways is 25 in.; over cross slide, 16 in. Base machine offered has center distance of 72 in., and is also available in 96 in. and 120 in. center distances.

Variable speed drive is direct to spindle through a PolyVee belt. Variable spindle speeds can be selected over constant torque range of 100 to 2200 rpm.

The lathe has a standard carriage and apron with four-way power traverse. Adjustment of the tool can be made in increments of 0.0001 in. through dial indicator on the bottom slide. Bed alignment is within 0.00025 in. over 36 in. A heavy built-in anti-friction type tailstock provides the rigidity needed for high finish results.

The Monarch Machine Tool Co.

Circle 82 on postcard for more data



PROCESS REDUCES COMPLEX STEEL SHAPES

A new method for milling high-strength steel parts of complex shapes is being licensed to manufacturers.

Called "electro - chemical milling," the process works on the electrolytic principle. The part is submerged in a chemical bath. An electric charge is then applied. Forgings, too contoured for conventional milling methods, are evenly "milled."

Columbus Div.
North American Aviation

Circle 83 on postcard for more data

continued on page 54

Titeflex, Inc., Meets Aircraft Fuel, Lubrication and Hydraulic Line Specifications with

HANDY & HARMAN BRAZE 541

Titeflex operator brazes assembly with torch and hand-fed Handy & Harman Alloy BRAZE 541. *Titeflex is unique in that it makes flexible hose assemblies from raw material to end product—"From End to End, Inside and Out, made RIGHT In Our Own Plant."*

This Springfield, Massachusetts, manufacturer of aircraft and missile fuel, lubrication and hydraulic lines finds that silver alloy brazing with Handy & Harman BRAZE 541 meets rigid operating requirements "all the way down the line."

The tubing and fittings of many of the wide range of assemblies made by Titeflex are 321, 316 and 347 stainless steel and Monel. Brazing is a hand torch, wire and HANDY FLUX operation.

BRAZE 541 is a plastic alloy which melts at 1325° F and flows at 1575° F. Its strength—in shear—at elevated temperatures is 21,500 psi at 500° F and 15,000 psi at 750° F. This alloy's ductility in resisting stress and vibration is very high and its resistance to oxidation and corrosion is equally impressive. The composition of BRAZE 541 is 54% silver, 40% copper, 5% zinc and 1% nickel. It meets AMS Specification 4772.

Aircraft and missile component manufacturers and fabricators are finding—to their and their products' benefit—that Handy & Harman silver alloy brazing is the full and *final* solution to their metal-joining problems. BRAZE 541 is but one of a large family of Handy & Harman alloys, for both low and high temperature applications. We would like to more fully acquaint you with BRAZE 541 and with the advantages that come naturally to silver brazing as a metal-joining (both ferrous and nonferrous) method. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits . . . includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

Your No. 1 Source of Supply and Authority on Brazing Alloys

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Circle 32 on Inquiry Card

(Advertisement)

Toward the preparation of man for the first steps into deep space, the Martin space medicine research program and space ecology laboratory facilities—now in development at the Denver Division—are among the most advanced activities in the free world. Especially noteworthy is the Martin Lunar Housing Similator. This will be a self-sustaining environmental closed system which will permit advanced study of survival requirements and techniques applicable to airless lunar or planetary conditions.

THE FIRST STEP

(Advertisement)

Martin-Denver is one of the eight divisions of The Martin Company

MARTIN
BALTIMORE·DENVER·ORLANDO

ELECTRON BEAM WELDER FOR JOINING METALS

Electron beam welder has a gun fully protected from gaseous discharges in the weld area. New unit is intended for laboratory and production welding of reactive metals which are best joined in a high vacuum, and of thin sections of more common materials such as stainless steel.

Welding is accomplished by directing a beam of high-energy electrons on the work from special gun positioned at the top of the welding chamber. This gun is equipped with a special protective feature giving a steady, continuous welding cycle regardless of operating conditions.

The welding chamber contains the work table, which can be moved laterally, longitudinally, and in rotation without breaking vacuum. The front of the chamber is a dished-head door. One 6-inch pump port and one 6-inch gun port are set into the tank; and three additional 6-inch ports allow for addition of extension chambers for long work or serve as alternate emplacements for the electron gun.

National Research Corp.

Circle 79 on postcard for more data

WIDE ARM RIP SAW

Wide arm saw has been developed with 48 in. ripping capacity from blade to overarm.

The improved Model "E," chain-fed, has 80 in. x 87 in. table. Feed speeds range from 56 to 225 F. P. M.

Ekstrom, Carlson & Co.

Circle 85 on postcard for more data

continued on page 56

BARCO FLEXIBLE JOINTS

For Handling High Energy Fuels....

.....liquid oxygen, white fuming and red fuming nitric acid, and JP 3, 4, and 5 fuel

4" special stainless steel Barco Flexible Ball Joint for handling liquid oxygen.

180° flanged 6" Barco Ball Joint for use in loading and unloading line handling liquid propellant.

-special designs for LOX and other Missile Fuels

Extensive design and manufacturing experience is yours to call upon at Barco for the handling of special liquid fuels in the aircraft, rocket, and missile industries:

—Flexible Ball Joints for metal loading lines handling corrosive fluids.

—Special flexible joints with leakproof seals for conveying fluids at low temperatures down to −300°F. Also high temperature designs up to +1000°F.

—Special designs resistant to nuclear energy radiation.

Barco joints provide flexibility *unlimited* for piping and tubing. Our engineers will be glad to work with you on special problems and assist with recommendations.

Flexible Hydraulic Lines for Missiles, Aircraft

MISSILE LAUNCHER HYDRAULIC ASSEMBLY

Barco produces high pressure self-aligning swivel joint and tubing assemblies for hydraulic pressures to 4,000 psi, and higher. Also a wide selection of standard and special swivel joints and assemblies for launching and flight gear. Sizes ¼" to 1". ASK FOR NEW CATALOG 269-A.

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MANUFACTURING CO., 565L Hough St., Barrington, Ill.

AIRCRAFT DIVISION

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Original engineering drawings are microfilmed and mounted into data-processing aperture cards with printer operating on the fast dry electrostatic principles of xerography.

From the data-precessing cards the printer automatically turns out dry, positive prints, translucent intermediates or offset paper masters for immediate use.

Cut prints emerge at the rate of 20 ft. per minute.

Haloid Xerox Inc.

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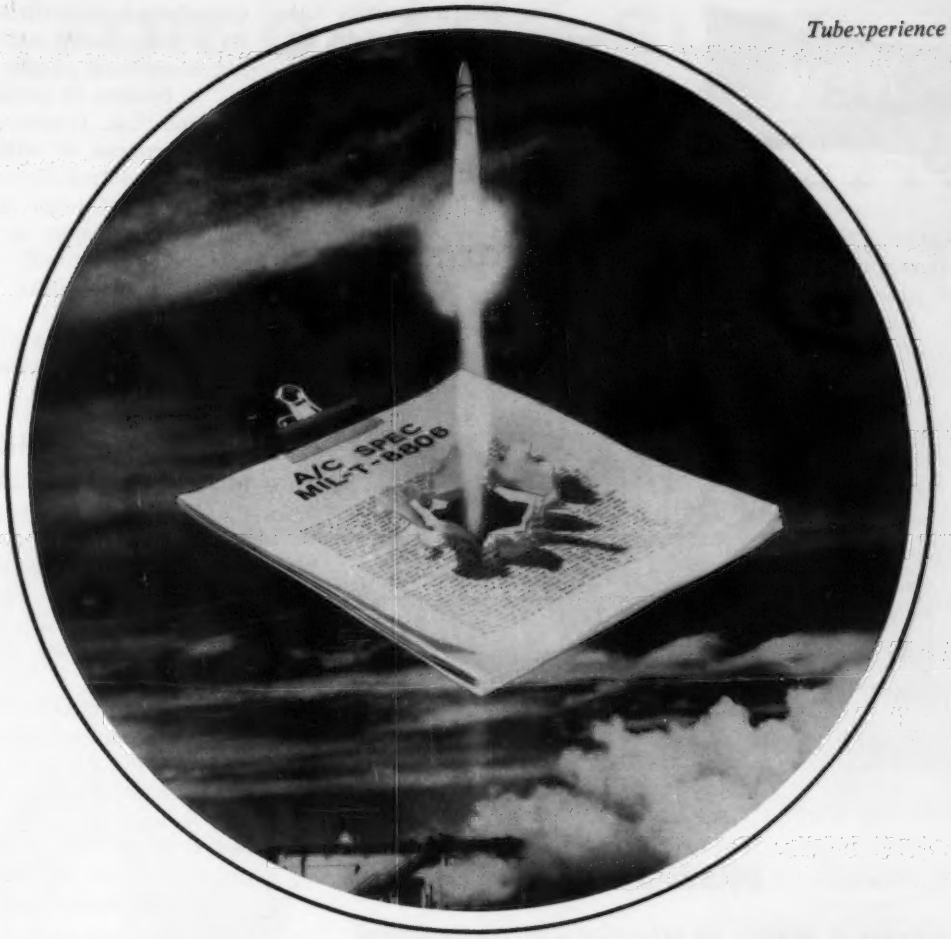
NEW DESIGN FEATURES IN VERTICAL BROACHER

Vertical broaching machine is designed with dead center pull on the broach. This eliminates stresses and strains previously experienced when pulling a large broach off-center.

Second significant feature: a turret has been adapted to the machine. Turret is six ft in diam., has 21 stations for storing the 80-inch-long broaches. Each broach is held in its own holder. Station 21 is an

continued on page 58

Tubexperience in action



How Superior Breaks the Spec Barrier in Stainless Hydraulic Tubing

Just meeting specifications isn't enough when you are producing stainless steel aircraft hydraulic tubing. More and more customers are asking for and getting "above normal specification" tubing from us, even though we now produce to 18 current MIL, AMS and AN Specifications.

Here are just a few of the *extras* requested by Superior customers in recent orders:

EXTRA LOW DEFECT LEVEL. We satisfied requirements by special production, verified by Eddy current inspection, the tubing being below .065 in. wall.

SPECIAL SPRING-BACK CHARACTERISTICS. Customer's requirements were met by producing the tubing to limited cold-worked temper range.

RESTRICTED MICROINCH FINISH LIMITS. Special drawing procedures and surface roughness inspection were used to achieve the finish required by the customer.

It is usual for Superior to do the unusual, since it is the world's most experienced producer of small-diameter tubing and has the widest range of analyses and sizes, plus the specialists to help solve puzzling tubing problems.

If you have a problem involving high-quality aircraft tubing and want the best combination of physical and mechanical properties, including high strength, ductility, fatigue and corrosion resistance, and good working qualities, consult us. We specialize in Seamless and Weldrawn® stainless steel aircraft hydraulic tubing in AISI Types 304, 321 and 347 in sizes ranging from .012 through 1.125 in. OD. Ask for Catalog 21, Superior Tube Company, 2053 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

open station for any type broach. It permits use as a conventional pull down broaching machine.

This 60 ton machine has 78 inch stroke, 36 ft height, 60 ton normal pull, 85 ton intermittent peak pull. Built-in programming uses push-button control panel.

The Lapointe Machine Tool Co.

Circle 80 on postcard for more data

PROGRAM CONTROL

"Master-Slave" program control system is designed for use where temperature uniformity is paramount, such as brazing honeycomb panels.

System is available with 3-action P. A. T. control for gas-fired furnaces, or with 3-action C. A. T. control for continuous regulation of input to electric heaters. As many as 24 zones may be automatically controlled by one Master-Slave Programmer.

Leeds & Northrup Co.

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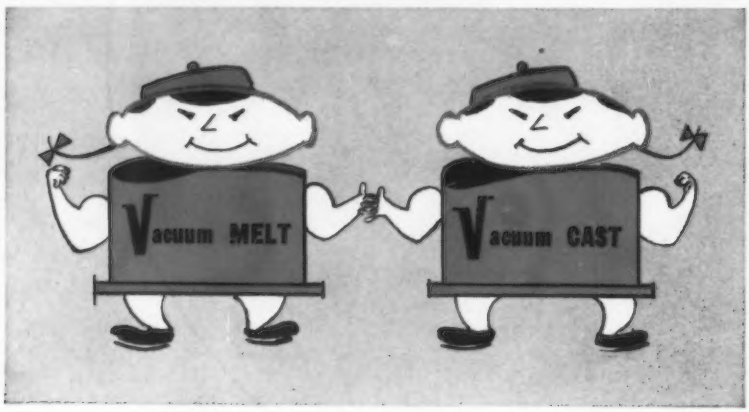

MISCO INTRODUCES "DOUBLE V"

A technique to enhance the properties of metals demanded by the aircraft, missile and space age vehicles.

"DOUBLE V" signifies the manufacture of cast components using *vacuum melted primary* ingots subsequently *remelted, poured in vacuum,* using investment or MONO-SHELL molds.

Misco engineers have designed vacuum equipment which permits continuous operation for High Volume Production. Charging of primary ingots, introduction of MONO-SHELL molds, melting and pouring, are carried out in vacuum through the ingenious use of charging locks.

For maximum benefits, melting temperatures are controlled optically and a vacuum pressure of 10 microns or less is maintained on mold and metal during pouring.

ORDER BY REQUESTING "DOUBLE-V"

V-PRIMARY VACUUM MELT V-CAST

Misco now provides a complete range of casting facilities to meet your requirements — AIR — INERT ATMOSPHERE — VACUUM, for your airfoil shapes now and in your future. *Send us your inquiries and details of your requirements.*

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Plants in WHITEHALL, MICHIGAN MUSKEGON, MICHIGAN

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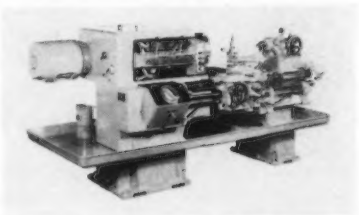
PRODUCERS OF AIRCRAFT AND INDUSTRIAL INVESTMENT CASTINGS

HEAVY DUTY LATHE MODIFIED IN HP, SPEED

Re-designed 2013 Clearing-Axelson lathe features increased spindle speed range (to 2000 rpm). Horsepower is 20 at 1800 rpm. There are 66 speed changes, plus 66 threading feeds.

The increased range allows precision machining heavy cuts of many types of materials at optimum turning speeds.

Gear box is enclosed for better lubrication, and elimination of foreign material. Gears are automatically lubricated.



Redesigned model also features hardened and ground headstock gears, bedways, and cross feed screws. Bedways, of tool steel, are replaceable. Apron, of double wall construction, encloses all gears except the rack pinion within an oil-tight housing.

A micrometer cross feed threading stop allows diameters for step shafts and threading to be controlled to .0005 in.

Swing over bed is 22½ in.; over carriage, 13¾ in.

Clearing Div. of U. S. Industries

Circle 81 on postcard for more data

FOR O_2 FOR SURE...

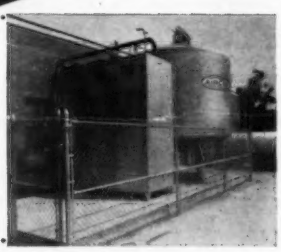
99.5% pure oxygen (O_2) ... by the ton or by the cylinder ... to a convenient location, inside or outside your plant ... for any process ... with absolute dependability

From more than 100 distribution and production points Airco today supplies American industry with oxygen and other high purity industrial gases. For the chemical industry ... missile fuel systems ... machine and manual cutting and welding ... steel making and processing ... flame hardening ... flame cleaning ... and for medical therapy and high altitude flight.

If you want to use oxygen for a new application or to improve the performance of current applications, Airco facilities are as near as your telephone.

Call in the Airco Engineering Service Representative. He is qualified to assist in planning a process with you from the very start. He is a long time expert in application techniques. He knows the rugged types of apparatus essential to oxygen processes. He knows in-plant distribution to consumption points. He knows how to make sure your supply will be ample at all times.

For O_2 ... Airco.



Right: Airco liquid oxygen station "installed" on customer site to assure large quantity storage for an uninterrupted supply.

Airco also supplies industry with ACETYLENE • ARGON CARBON DIOXIDE • HELIUM HYDROGEN • KRYPTON NEON • NITROGEN • XENON

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CAN YOU GUESS

The Rupture Pressure Of A ¼" Rupture Disc Made From This Paper-Thin Piece Of Stainless Steel By BS&B?

Rupture Disc Metals

Aluminum	Platinum	Nickel
Silver	Stainless	Monel
Copper	Inconel	

Rupture Discs are performing a wide variety of pressure relief and actuation functions on many of today's most advanced aircraft, missiles, rockets and submarines.

Here we show a few of these functions to illustrate the versatility of the rupture disc's basic principle in application and design. Perhaps one of them will suggest an answer to your pressure control requirements.

ANSWER:

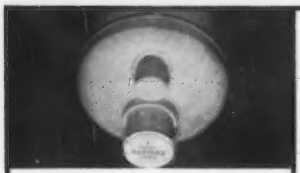
Size	Rupture Pressure PSI @720 F.
¼"	2125
½"	1040
1"	515
1½"	350
2"	205
3"	145
4"	115
6"	85
8"	67
10"	59
12"	50
16"	37
20"	30

Pressure as low as 5 psi can be attained in large diameters; up to 100,000 psi in small sizes.

Sizes from ⅛ inch up.

Service temperatures from sub-zero up to 1000° F.

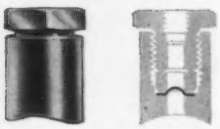
BS&B will design and fabricate any device to hold the rupture disc to your space and weight specifications.



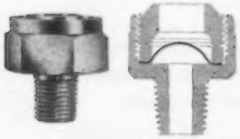
Rupture disc in larger fitting restrains the thrust of a "Jato Bottle" until the ignited propellant develops a specified pressure. When the desired thrust value pressure is reached, the disc ruptures to provide instantaneous exhaust and resultant thrust. Disc in the small fitting is a safety device for overpressure relief.

Rupture disc in this fitting is used in underwater service. At a specified pressure the disc ruptures to actuate a trigger mechanism.

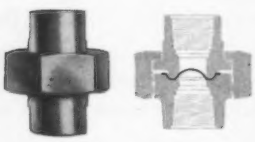
This device fits in the outer shell of a vacuum insulator vessel containing a fuel component. The rupture disc protects against dangerous pressure build-ups which might occur if the inner shell should break or leak.



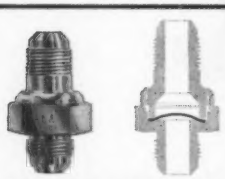
This rupture disc fitting is used on seat ejection mechanisms to lessen shock by the dissipation of excess thrust pressure.



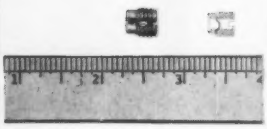
This disc assembly is used to protect against overpressure in air conditioning systems of commercial aircraft.



Here a rupture disc serves as a vital component in power supply of nuclear powered submarine.



Simultaneous rupture of the discs in two of these fittings triggers the mixing of a fuel and oxidizer.



Rupture disc in this tiny fitting protects against overpressure in a missile's hydraulic control system.

Large diameter (24") Safety Heads are fitted in manifold to provide overpressure protection on this engine test chamber.

BS&B — Efficiency, Over 40 Years, Reliability — Another Example of Product Leadership

May we suggest further investigation of rupture disc applicability to your pressure control requirements? For engineering consultation call or write . . .

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-GC10
7500 East 12th Street
Kansas City 26, Missouri

Mission: **MAN IN SPACE**

Filter Application: **PROTECT HYDRAULIC CONTROLS**

Filter: **PUROLATOR**

A malfunction in the lines of the hydraulic and pneumatic controls of the X-15 could send it off its programmed trajectory . . . alter the angle of re-entry . . . cause deviation from the ballistic arc.

Purolator filters are on the X-15 to protect the control systems. Three new filtering applications were worked out for North American Aviation, designers and builders of the X-15, by Purolator engineers to meet the space-age requirements of the manned missile.

Filters for crucial aircraft and missile requirements are a specialty at Purolator . . . and every application is considered as crucial as those on the X-15. Draw on Purolator's experience to help you handle your filtration requirements. A phone call or a descriptive letter, with plans or blueprints, will receive prompt attention.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

Circle 39 on Inquiry Card

Just One Squeeze with IDEAL's New "Custom Stripmaster" Removes Teflon* and Other Hard-to-Strip Insulations

To help prevent wire nicking and insulation damage, these new IDEAL "Custom Stripmasters" are precision drilled on watchmaker's equipment.

With Ideal's new Custom Stripmasters, a light squeeze on the handles strips any wire completely clean and bare up to a full ⅞ inch.

To help prevent nicking and scraping of wires, the Custom Stripmaster's matched sets of blades are precision drilled on watchmaker's equipment to the exact wire sizes. Counterbored blades ride on cut insulation to prevent scratching of stripped wire. Jaws grip wire firmly to prevent insulation damage. 3 models available. Wire sizes from No. 10 to 30.

*Reg. Trademark of DUPONT

Custom Stripmaster® Patented, No. 2,523,936 by IDEAL

IDEAL INDUSTRIES, Inc.
1390-J Park Avenue, Sycamore, Ill.

Gentlemen: Please send catalog information on IDEAL's New "Custom Stripmaster."

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Company_____
Address_____
City_____ Zone____ State_____

Circle 40 on Inquiry Card

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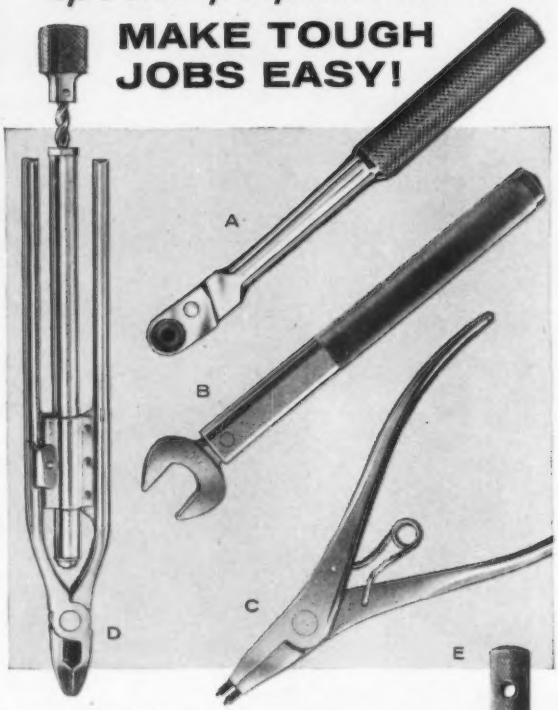
special purpose tools

MAKE TOUGH JOBS EASY!



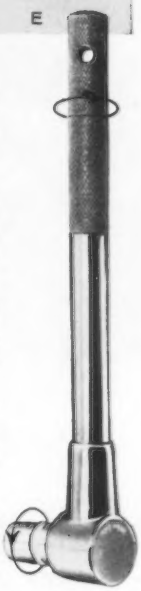
A. MILBAR CLOSE-CLEARANCE RATCHET WRENCH for tightening or removing twelve-point or hex-head screws and nuts. Fits in the tight spots where regular wrenches won't work. Smooth ratchet action. Several sizes available. Widely used in aircraft and missile industries.

B. MILBAR SNAP TORQUE TOOL—with pre-set torque. A "click" you can feel and hear tells when proper torque is reached. A choice of head types for specific jobs. Widely used on production lines in the automotive and aircraft industries.

C. MILBAR SNAP RING TOOL—the original and most widely used tool with replaceable points of different shapes and sizes. Tool lasts forever—just change points for the job at hand or when they wear out. Special points for holeless snap rings.

D. MILBAR WIRE TWISTER—for smooth, automatic one-hand operation. Extra large serrated jaws assure a longer life and non-slip grip. Spring return and squeeze release eliminates need for shifting hands. Twists and cuts wires with no waste motion.

E. MILBAR GEARED RIGHT-ANGLE TOOL—for easy access to "tight" spots. Fits all standard ⅜" drive extensions, sockets and ratchets. Reaches around corners and delivers increased torque for tightening or removal. Eliminates unnecessary removal of parts to get at the job to be done. Fully proven and tested by thousands of users.



Send for your free brochure describing these, and other, MILBAR Special Purpose Hand Tools. MILBAR has the engineering facilities and personnel to solve your special problems where sufficient volume is involved.

MILBAR CORPORATION
1900 EUCLID AVENUE • CLEVELAND 15, OHIO

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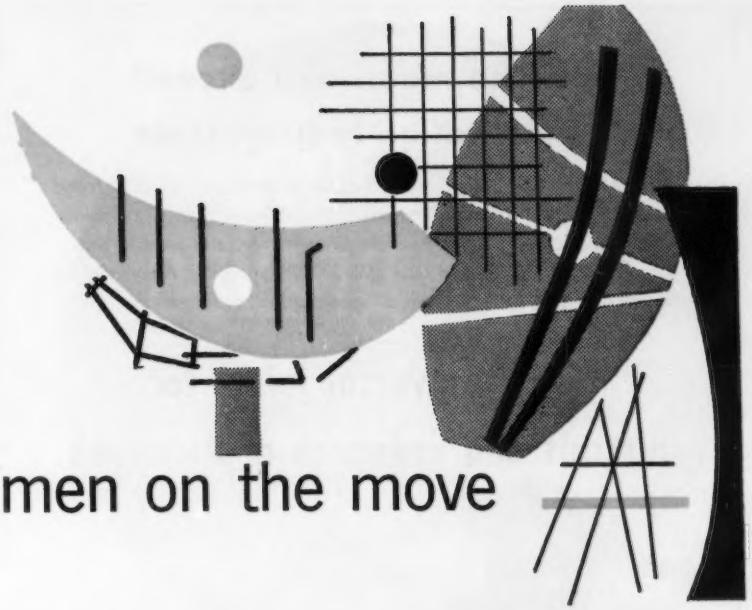


men on the move

DR. JAMES H. TURNOCK, JR., named IBM Project Manager for Project Mercury. IBM will write detailed instructions for the large-scale electronic computers which will keep track of the manned capsules' instantaneous positions, and compute their impact location. JOSEPH D. FERNBACH, named manager of manufacturing at the Owego, N. Y., facility of IBM's Federal Systems Division.

ZEMBRY P. GIDDENS, named executive vice president, Dynamics Corp. of America.

JACK M. BEAUCHAMP, appointed director, Customer Relations Div., Aerojet-General Corp.

GLENN N. HACKETT, appointed director of purchases and traffic for Thompson Ramo Wooldridge Inc.

PAUL G. MAYER appointed general sales manager of Loewy-Hydropress Div., The Baldwin-Lima-Hamilton Corp.

LOREN K. HUTCHINSON, promoted to works manager for the Worcester plant, Wyman Gordon Co.

ROBERT L. RUTH, appointed chief engineer of the Marine and Ordnance Department, Vickers Inc.

PERRY V. OGDEN, appointed Manager of Material, Summers Gyroscope Co.

DR. CHARLES F. ROBINSON, appointed associate director of research, Consolidated Electrodynamics Corp.

JEROME I. DAVIS, named vice president of the aircraft equipment division, Consolidated Diesel Electric Corp.

SOCRATES VAVOUDIS, named director of engineering: Jerome Greenberg, named general sales manager, at Itemlab Inc.

WALTER C. WILLIAMS, Chief of the NASA's High-Speed Flight Station at Edwards, Calif., has been named an Associate Director of Project Mercury.

THOMAS B. RHINES, promoted assistant engineering manager; Donald G. Richards, named chief engineer, at Hamilton Standard, division of United Aircraft Corp.

ROGER A. SWANSON, appointed product sales manager—microwave diodes, for the Semiconductor Division of Sylvania Electric Products,

S. MICHAEL TREMAN, appointed manager of design and technical engineering, Missile Systems Div., Republic Aviation.

WALKER C. BROWNLEE, elected administrative vice president of the Garrett Corp.

HAROLD ASQUITH, named NATO Hawk program manager by the Missile Systems Div., Raytheon Co.

EDWARD A. VOSS, appointed manufacturing manager of the Cincinnati div., Bendix Aviation Corp.

EDWARD G. UHL has joined Ryan Aeronautical Co., as vice president, technical administration.

CHARLES C. BOTKIN, named manager of the new Missile, Arming and Fuzing Program Office, Missile and Space Vehicle Department, General Electric Co. ROBERT J. KIRBY, named manager of the Department's nuclear ordnance projects operation.

DR. FINN J. LARSEN, named vice president in charge of research for Minneapolis-Honeywell Regulator Co.

Barnett Pomerantz
Bulova

George Kunstadt
Martin

BARNETT POMERANTZ, appointed project engineer at Bulova Research and Development Laboratories for the firm's aircraft altimeter development and production programs.

GEORGE H. KUNSTADT, appointed technical director of the Ground Support Equipment Department, Baltimore Div., Martin Co.

DR. ALEX E. S. GREEN, appointed chief of physics at Convair (San Diego) Div., General Dynamics Corp.

C. E. (ED) DEARDORFF has joined Southwestern Industries, Inc., as Chief Engineer.

Charles C. Botkin
General Electric

Dr. Finn J. Larsen
Minneapolis-Honeywell

Dr. Alex E. S. Green
Convair

C. E. Deardorff
Southwestern Industries

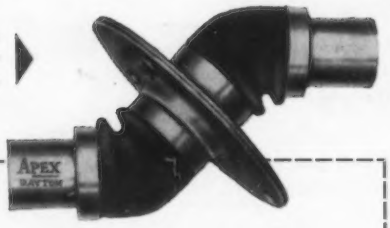
built to meet—and exceed specification requirements

Unique structural design, and sealed, lubricant-retaining covers found only on Apex universal joints make possible universal joint applications never before feasible. Available in a full range of sizes, in heavy-duty (MS-20271) and light-duty (MS-20270) types, all Apex military universal joints meet or exceed all specification requirements.

APEX universal joints for aircraft and ordnance applications

One standard hub, and one drilled and splined hub end are used on this Apex covered universal joint in a wing flap actuating system.

Double universal joint for bulkhead mounting. Both joints and the center bearing are protected and provided with sustained lubrication.



and engineered for special applications

Apex offers a complete engineering service on new or special universal joint applications. For critical systems having little or no initial backlash, or to maintain a lash-free system for extended periods of service, Apex can furnish universal joints with backlash limits ranging below .08°. Zero backlash can be achieved, if desired.

Catalog 28 contains complete information, and includes a very helpful Application Data Sheet. Write, on your company letterhead please, for your copy.

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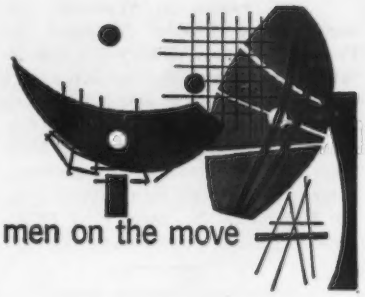
APEX



DR. ALEXANDER H. FLAX, vice president and technical director of the Cornell Aeronautical Laboratory, is beginning a one year appointment as scientific adviser to the Air Force Chief of Staff. HAROLD A. CHEILEK, appointed assistant technical director of the Laboratory. ABRAHAM HERTZBERG, appointed head of CAL's Aerodynamic Research Department.

Robert Geiger
Twin Coach

Dr. Ernst A. Steinhoff
Avco/Crosley

ROBERT GEIGER, appointed project development manager of the Twin Coach Co.

DR. ERNST A. STEINHOFF, appointed director of the newly-formed Missile Department, Crosley Div., Avco Corp.

DR. PETER A. CASTRUCCIO, appointed technical director of the new Aerospace Div., Aeronca Mfg. Corp., Baltimore. JOSEPH A. WASCAVAGE, named director of marketing at the division.

CHARLES E. MAKI has been appointed chief development engineer and head of a new "accessories group" at MB Mfg. Co.

Dr. Peter A. Castruccio
Aeronca

Charles E. Maki
MB Mfg. Co.

Du Pont

New 32-page booklet "The Story of Man And His Work."

E. I. Du Pont de Nemours & Co.

Circle 98 on postcard for more data

Environmental Facilities

Thirty-one page booklet on capabilities for reproducing a wide variety of environmental characteristics.

Missile and Space Vehicle Dept.
General Electric Co.

Circle 90 on postcard for more data

Power Cable

Product data and ampacity of Durasheath all-purpose rubber power cable.

Anaconda Wire & Cable Co.

Circle 102 on postcard for more data

Designer's Fact Book

206 page Fact Book describes over 50 industrial Formica laminated plastic grades.

Formica Corp.

Circle 92 on postcard for more data

Machining Metals

Outline of firm's equipment, with its uses.

Ravenna Metal Products
Div. of Standard Screw Co.

Circle 96 on postcard for more data

Chem-Mill

Brochure describes firm's activity on chemically milled parts.

Chemical Milling International Corp.

Circle 91 on postcard for more data

Ablation Materials

Technical bulletin describes the properties of reinforced plastic resin systems as ablation materials for reentry into the earth's atmosphere.

Zenith Plastics Co.

Circle 87 on postcard for more data

Magnetrons

Bulletin PT-1 on four new S-band packaged voltage-tunable magnetrons.

Power Tube Dept.
General Electric Co.

Circle 97 on postcard for more data

Thread Rolling Machine

Bulletin E-101 includes capacities, design, and operating features on Lan-Nu-Rol thread rolling machine.

Landis Machine Co.

Circle 107 on postcard for more data

High Temperature Steels

Technical Data Brochure covers high strength, high temperature steels for critical structural applications in airborne vehicles.

Universal Cyclops Steel Corp.

Circle 106 on postcard for more data

Nialk Trichlorethylene

Revised brochure, "Nialk® Trichlorethylene for Vapor Degreasing and Other Uses."

Hooker Chemical Corp.

Circle 101 on postcard for more data

J85

GED-3923, 12 pages, describes the new J85 turbojet.

General Electric Co.

Circle 93 on postcard for more data

Cut-Down Machine

Bulletin on the "58" saw for metalworking.

Irvington Machine Works

Circle 104 on postcard for more data

Mobile Ladder

Bulletin on "Saf-Lad" mobile ladder truck.

Saf-Lad Mfg. Co.

Circle 95 on postcard for more data

Spring Clutches

Catalog describes five standard lines of spring clutches in bore sizes from ⅛ in. to 1 in. and torque capacity up to 1250 lb. in.

Marquette Div.
Curtiss-Wright Corp.

Circle 105 on postcard for more data

Power Connectors

Catalog covers external power connectors used in aircraft and missile ground support.

Albert & J. M. Anderson Mfg. Co.

Circle 89 on postcard for more data

Molecular Sieves

8-page brochure explains how Molecular Sieves get their ability to "wring" water from fuels.

Linde Co.
Div. of Union Carbide Corp.

Circle 100 on postcard for more data

Sintered Metal Parts

4-page bulletin treats process of producing Sintered Metal Parts; includes physical characteristics, mechanical properties, economies, and applications.

Burgess-Norton Mfg. Co.

Circle 99 on postcard for more data

Dry Hydrogen Brazing

Brochure describes abilities and facilities of firm in the pure dry hydrogen brazing of copper, silver, nickel and other alloys.

Western Alloy Engineering Co.

Circle 88 on postcard for more data

Jaws

Bulletin on line of quickset jaws.

Worthington Corp.

Circle 94 on postcard for more data

Kellett

Pictorial presentation of R & D work, facilities.

Kellett Aircraft Corp.

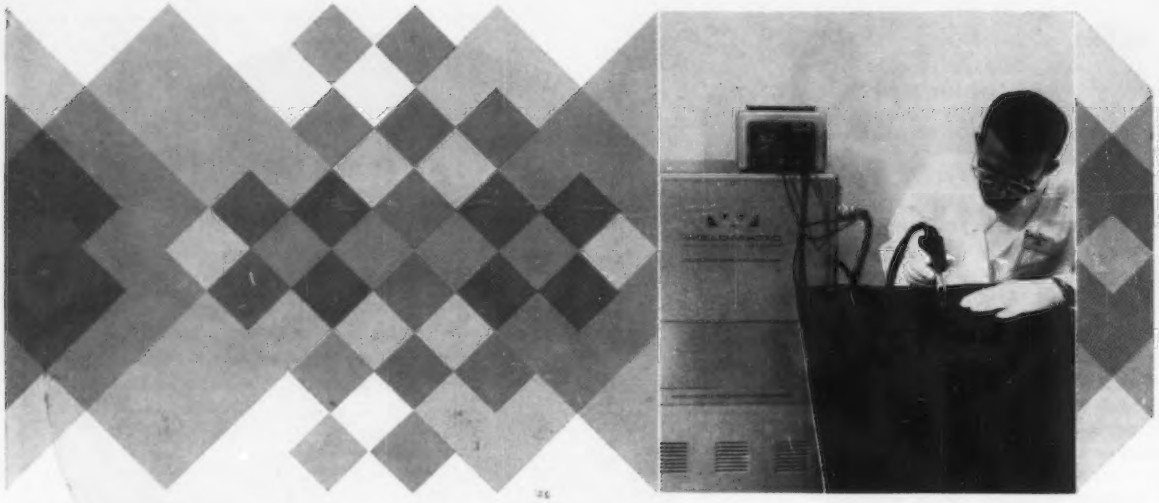
Circle 103 on postcard for more data

Waugh Services

Engineering booklet on line of flow pick-ups, flow measuring systems.

Waugh Engineering Co.

Circle 108 on postcard for more data



AEROJET SPOTWELDS HONEYCOMB SECTIONS FOR STRENGTH AT BRAZING TEMPERATURES

The powerful combination of a Weldmatic 1024 Power Supply and a Model 1028 Control Unit are used by Aerojet-General at its Downey plant to spotweld stainless steel honeycomb sections to edge members with brazing foil sandwiched in between. Approaching brazing temperatures, these spotwelds hold position of the honeycomb section. Up to five layers of stainless steel and brazing foil are welded at one time — proof that this welding team can handle those heavy-duty applications. Write for new technical information on heavy-duty resistance welding.

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370 NORTH HALSTEAD AVENUE, PASADENA, CALIFORNIA

DIVISION OF UNITEK CORPORATION

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LONG-
LOK
SELF-LOCKING SCREWS
• Eliminate safety wire, lock washers, and staking • Resist vibration • Wide temperature range • High reusability • Meet requirements of MIL-F-18240 Specifications.
Whatever your fastener requirements may be, Long-Lok Self-Locking Screws assure highest reliability, plus substantial cost savings in weight, time and labor. Available in aircraft and commercial qualities. Write for free Bulletin LL-58.
LONG-LOK CORPORATION
2601 Colorado Avenue • Santa Monica, Calif.

industry notes

MERCURY PROGRESS

Final NASA decision for *the* Mercury space capsule shielding material may not come until next year.

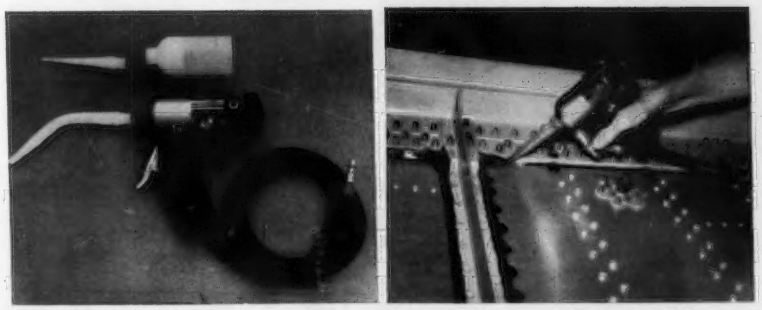
It may be an ablative plastic instead of beryllium, reported earlier as the definite choice.

Capsule's inside shell is an aluminum-titanium alloy, according to NASA. Styrofoam molded-plastic coach, in which the astronaut reclines in supine position, back towards re-entry face, is reinforced from thighs to head with a seven-inch-thick layer of aluminum honeycomb. This cushions up to about 75 g's.

The capsule was tested with partial success early in September using a "Big Joe" (Atlas D) booster. Test of the escape system in August failed because the escape rocket fired before North American's "Little Joe" booster. Radioplane Div., Northrop Corp. is testing the parachute system with models over the Salton Sea.

Actual re-entry is slated to begin over the West Coast. Pilot guides during orbit or re-entry only if automatic guidance needs correction.

SEALING THE DC-8



Sealant is applied to wing section joint of Douglas DC-8 with application gun from Semco Research Co. Polyethelene cartridge holds PR-1422, sealant developed by Thiokol Chemical Corp. and processed by Products Research Co.

SOVIET PRECISION ACHIEVES THE MOON

Stabbing the moon with a hammer and sickle suggests a few footnotes on Russian reliability.

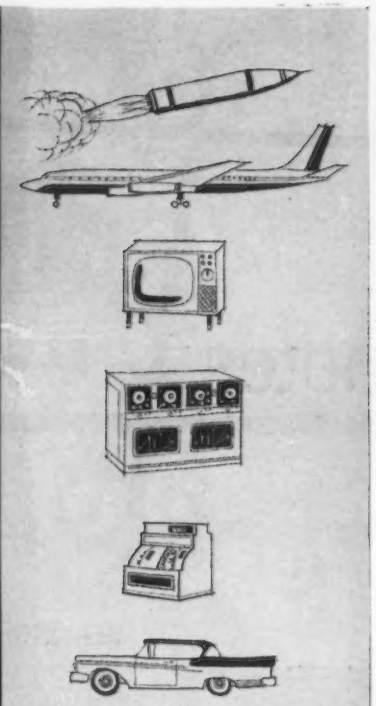
According to the calibration survey report of the Aerospace Industries Association, an error in accuracy of *one millionth of an inch* in the borehole of a gyro could have caused an error of .03° per hour drift, and resultant failure.

To put a payload on the moon, Russian scientists held cut-off velocity within 75 ft per sec of the 35,000 ft per sec needed to get to the moon. The injection angle was less than a half deg. off.

ARMA REACHES THIRD GENERATION SYSTEM

Factors in new generation miniaturized inertial system developed by Arma Div., American Bosch Arma: floating gimbals in lightweight, 2 axis gyro are beryllium instead of aluminum and magnesium; spin bearing design has been improved; gyroscopic floated sensitive element uses fine wires instead of pivots. System could be used in Space Navigation. A third generation system under study represents a 70 per cent reduction in weight and volume over second generation. Sensing platform and control electronics are packaged in a weight-saving "inertial measurement unit."

one product ties all these together...



BERYLLIUM COPPER ELECTRICAL CONNECTORS

Where performance is mandatory ... where failure must not occur ... "Berylco" beryllium copper provides the vital link between electrical components in aircraft/communication/business machines. Excellent fatigue life, combined with the high spring and electrical properties of beryllium copper, insure positive (corrosion-free) contact with the *minimum of surface contact resistance.*

Do you have such a problem? Write us today for descriptive literature and engineering data. Qualified technical assistance is always as close as your phone.

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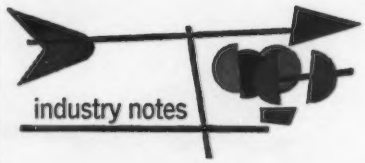


REPUBLIC'S R & D CENTER NEARS COMPLETION

Republic Aviation's new research and development center will house some $9-million in special hardware for the astronautics era.

Among the projects to be pursued at the new Farmingdale facility scheduled for December 15 completion:

• Testing men, manufacturing techniques, and materials in a 30 ton space-environment chamber being built by Tenney Engineering. 30 ft. long, with 14 ft. diam., it will simulate heights of 150 miles and incorporate what are reportedly the largest cold cathode type vacuum pumps ever made.

In Republic Aviation study, flask boils liquid human waste. Water vapor is condensed (right) and fed to rats. They have been on this diet a month —roughly equivalent to 2½ years for a human.

• Water recovery. Republic fed rats water distilled from human urine for one month. This is reportedly equivalent to a human drinking this water for 2½ years. Republic is developing light weight equipment for water recovery. Preliminary results are very encouraging. The firm is not yet

certain however, that every chemical toxic to humans has been removed.

• A new method of applying electrical energy to metal-forming. A series of electrical explosions inside a water-filled tube cause a shock wave travelling through water at high velocity to "form" exotic metals. Adolph Kastelowitz, director of manufacturing research, says the "spark bomb" project grew from the firm's interest in explosive forming. He estimates that a small prototype machine will probably be developed within a year, and that larger machines may eventually replace conventional hydraulic presses.

• The "lunar garden." Batches of dwarf tomatoes, spinach, carrots, and snap beans are being raised in belljars under simulated pressures of 8,000, 16,000 and 27,000 ft. Data could be used to grow vegetables on the moon in pressurized greenhouses, shielded against heat and cold, since germination cannot take place unaided in the high vacuum lunar environment.

• Hypersonic shock tunnel, 100 ft. long, designed by Republic to test models between Mach 10 and Mach 20 at temperatures approaching 20,000°F. It will be located in the re-entry simulation lab along with a plasma jet facility producing 25,000°F.

• Developing hydraulics and pneumatics up to 1500°F and 5,000 psi in new Advanced Fluid Lab. Republic has already tested a fluid at 1,000°F for nine hr. before a hardware breakdown. Component testing will take place remotely. Separate areas will handle liquid systems, gas systems, and complete systems.

A "guidance and control" laboratory will contain sophisticated equipment for research

continued on next page

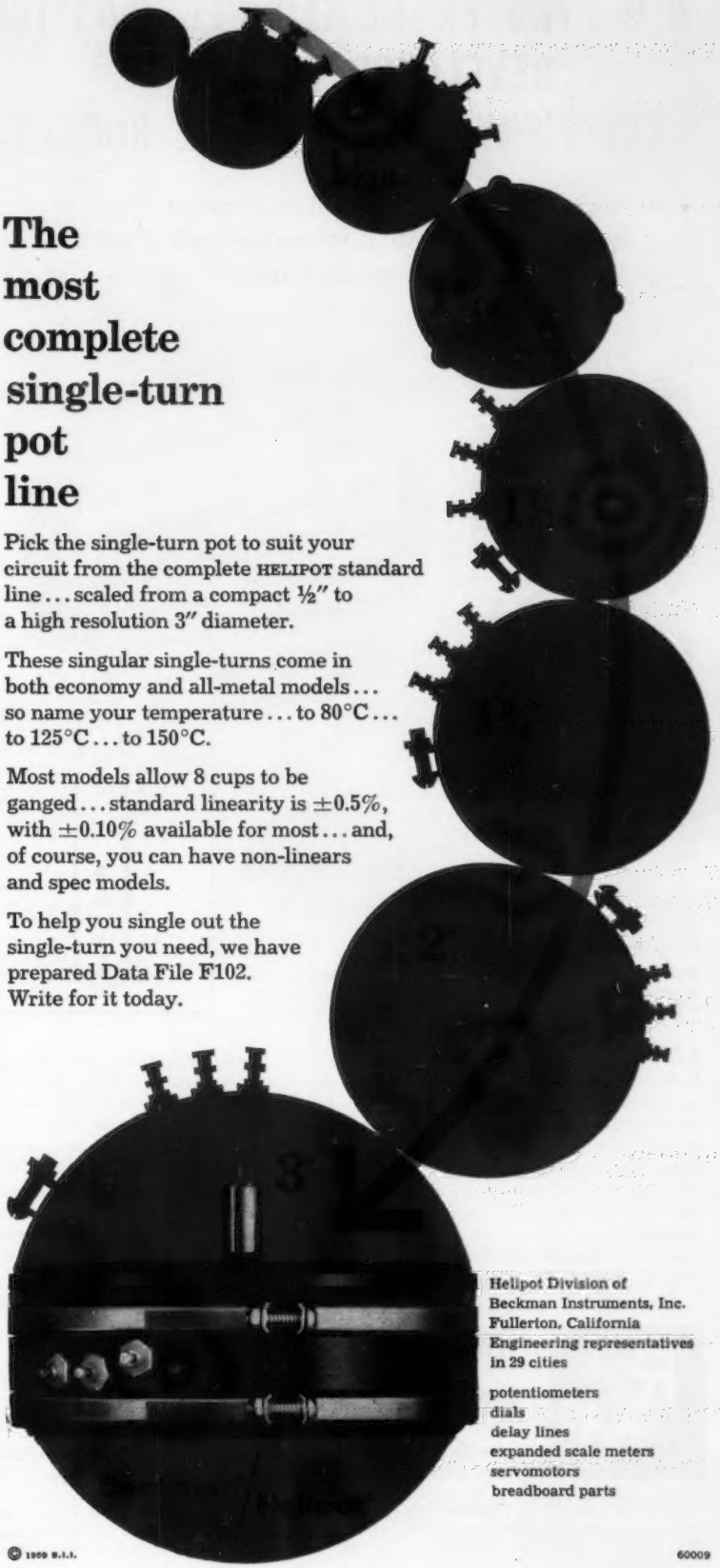
The most complete single-turn pot line

Pick the single-turn pot to suit your circuit from the complete HELIPOT standard line... scaled from a compact ½" to a high resolution 3" diameter.

These singular single-turns come in both economy and all-metal models... so name your temperature... to 80°C... to 125°C... to 150°C.

Most models allow 8 cups to be ganged... standard linearity is ±0.5%, with ±0.10% available for most... and, of course, you can have non-linears and spec models.

To help you single out the single-turn you need, we have prepared Data File F102. Write for it today.



Helipot Division of
Beckman Instruments, Inc.
Fullerton, California
Engineering representatives
in 29 cities

potentiometers
dials
delay lines
expanded scale meters
servomotors
breadboard parts

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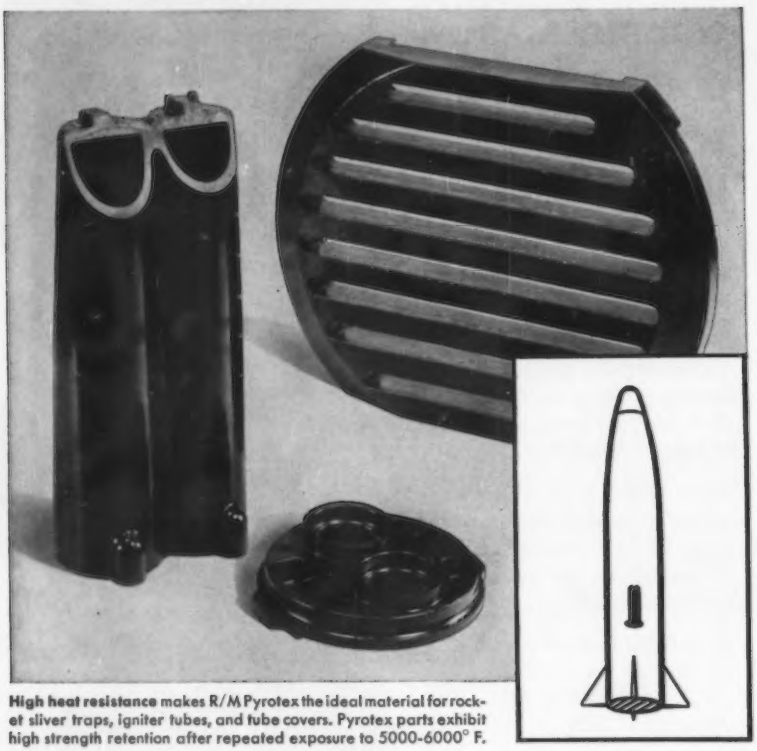
R/M PYROTEX® REINFORCED PLASTICS ...DEVELOPED TO ENDURE THE FIERY REALM OF THE ROCKET

Light, strong, heat resistant . . . for low-cost, precision fabricated rocket parts— both structural and aerodynamic



High heat resistance makes R/M Pyrotex the ideal material for rocket sliver traps, igniter tubes, and tube covers. Pyrotex parts exhibit high strength retention after repeated exposure to 5000-6000° F.

Looking for a material that will withstand the elevated temperatures generated by missiles and rockets—internally from burning propellants, externally from aerodynamic heating? Must this material have good insulation and thermal properties, chemical and water resistance, and take a smooth finish? If so, one of R/M's family of Pyrotex reinforced plastics may be the solution to your problem.

The many outstanding thermal and structural features of R/M Pyrotex have led to its use on almost every U.S. missile. It has been fabricated into parts such as nose cones, fins, igniter tubes, rocket throats and sliver traps. Its exceptionally good dimensional stability makes possible mass production to precision standards. And it is low in cost. Write for additional information.

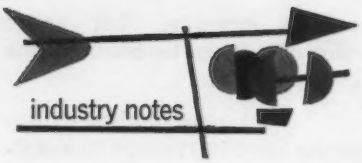
R/M

RAYBESTOS-MANHATTAN, INC.

REINFORCED PLASTICS DEPARTMENT, Manheim, Pa.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; Paramount, Calif.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Engineered Plastics • Mechanical Packings • Sintered Metal Products • Industrial Rubber • Rubber Covered Equipment • Brake Linings Brake Blocks • Abrasive and Diamond Wheels • Clutch Facings • Industrial Adhesives • Bowling Balls



into space navigation, optics and infra-red, and digital computors.

Pure and applied research on materials for advanced aircraft and space travel will take place in Materials Development Lab. The Electronics Lab. will include an Anechoic Chamber to study techniques for "hiding" vehicles in space by making them non-reflective to radar pulses.

A nuclear radiation and radiochemistry lab will conduct research in power sources, measurement techniques and environmental effects of radiation. A particle accelerator will probably be built on the roof of the facility.

The one story lab area comprises some 52,000 sq. ft. with the two story technical support and administration area covering an additional 67,500 ft. Center will house some 550 employees. Full-scale R & D work is expected to begin in March, although some research projects will be underway in the building by January.

SATELLITE I. Q.

COURIER-delayed relay satellite generally akin to Project Score's "talking" satellite. First of 500 lb. orbiters is scheduled to be launched in February, with capacity of handling 40 incoming and outgoing teletype messages simultaneously.

NOTUS-program for communications satellites, one of which hovers 22,400 ft. over the equator and covers to within about 18 deg. of the poles. Other satellites orbit over North and South poles.

TIROS-250 lb meterological satellite to be launched about April, 1960.

This is all the room you need to weld with LINDE's "MIGHTY MIDGET"

SHOWN ACTUAL SIZE IN 3-IN. OPENING

. . . New Heliarc HW-20 Torch

HIGH CURRENT CAPACITY

Operates at 200 amperes *continuous* duty, AC or DC. Molded, totally closed water-cooling system eliminates any chance of leaks at torch head.

MINIATURE SIZE

9/16- by 2-5/16-in. torch head permits welding in hard-to-reach areas as small as 3 in. in diameter. Total torch length is under 7 inches.

3.3-OZ. FEATHERWEIGHT

Selected materials, such as glass fiber reinforced phenolic plastic, save weight without sacrificing strength. Torch (with short cap) weighs only 3.3 ounces.

HANDLES LIKE A PENCIL

Exceptional balance, light weight, small size, and super-flexible service lines make the HW-20 torch as easy to handle as a pencil.

For further information, call your local LINDE Office or LINDE Distributor . . . or write: Dept. AMM-10, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

SPECIFICATIONS

Capacity—
200 amp. AC or DC, continuous duty cycle;
225 amp. AC or DC, reduced duty cycle

Weight—
with short cap: 3.3 oz.*
with medium cap: 3.5 oz.
with long cap: 3.6 oz.

Length overall—6⅞ in.

Length of Torch Head—
with short cap: 2-19/64 in.*
with medium cap: 3-9/32 in.
with long cap: 7-5/16 in.

Maximum Handle Diameter—¾ in.

Maximum Head Diameter—9/16 in.

Service Lines—12½ or 25 ft.

*Torch is supplied with medium cap for 3-in. electrodes. Short cap for 2-in. electrodes and long cap for 7-in. electrodes are available as accessories.

Linde UNION CARBIDE

The terms "Heliarc," "Linde," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

A topper in any language

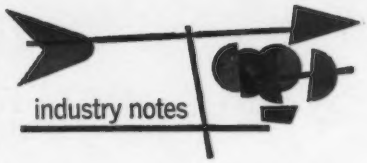
It's better than the best XXXP grade, it's lighter and more economical than G-10, it's Taylor XY-1 Paper-Base Epoxy Laminate

When you want extremely high reliability in printed circuits, with the additional advantages of flame retardance, chemical resistance, good solderability and high bond strength—specify Taylor XY-1 copper-clad laminate. It is self-extinguishing in 1 second, has excellent resistance to alkalis, acids and solvents, has a solder time resistance at 500°F. of 30 seconds in 1-oz. copper and 50 seconds in 2-oz., and a bond strength of 10 lb. in 1-oz. copper and 13 lb. in 2-oz. Sheets available with copper on one or both sides.

Unclad Taylor XY-1 has many advantages, too. It can be substituted for glass-base epoxy laminates to reduce cost and weight. It has excellent electrical, mechanical and machining properties. Contact us for complete technical data and expert guidance in applying this new material. TAYLOR FIBRE CO., Norristown 50, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE



CONTRACTS . . .

Avco Corp. will continue research and development of a re-entry nose cone for **Minuteman** unde a $36,655,000 Air Force prime contract.

General Electric and Bendix Aviation will work on the polar communication portion of **Program Notus,** the global communications satellite program. The former will develop the satellite vehicle system for about $5.5 million. Bendix will develop the communications subsystem for about $8.5 million. The Air Force will administer both contracts.

An additional $29-million goes to GE for production of **Thor nose cones.**

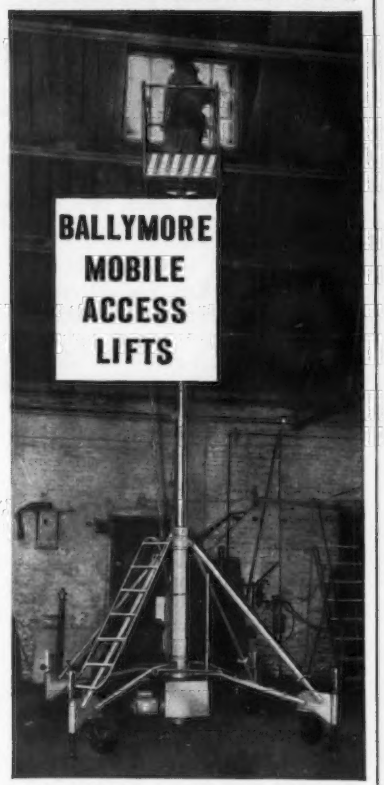
Bell Aircraft will provide its hydrogen peroxide "reaction control" thrust chambers for **Project Centaur** under a $380,000 contract from Convair/Astronautics Div., General Dynamics Corp.

The General Atomic Div. of General Dynamics received $1-million from the Department of Defense for a year's extension on its study of **rocket propulsion by small nuclear explosions.**

Reaction Motors Div., Thiokol Chemical Corp., received an Air Force contract (amount undisclosed) for advanced development of mechanical features in **pre-packaged liquid rocket engines.** Aerojet General's Aeronautics Div. received $4.9 million to develop surveillance system for SD-2 drones.

In aircraft, Sperry Gyroscope Co. received $142-million to produce inertial bombing-navigation systems and ground

NEW METHODS FOR REACHING HIGH PLACES SAFELY...



For working easily and safely at levels up to 40 feet above the floor, there's nothing like Ballymore Mobile Access Lifts. These power platform lifts are readily portable and, by using levelizing jacks, maintain a steady, firm position at any location. When folded, the lifts pass through narrow openings, into and out of elevators.

A push-button switch on the guardrail gives the user complete control of the lift. Used indoors and out for an almost endless variety of jobs. Six different models available for maximum reaches of 19 to 42 feet.

Write today for complete information to the Ballymore Company, West Chester 27, Pa.

HYDRAULIC LIFT WORK PLATFORM

Another Safety Product by Ballymore. Designed for safe use at levels between 7 and 20 feet. Can accommodate up to 3 men. Portable, flexible, safe. Write for details.

LOOK FOR THIS LABEL
TO BE SURE
IT'S THE BEST!
BALLYMORE COMPANY
WEST CHESTER PA
Ballymore

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support equipment for the first operational B-58 SAC wing. The Navy awarded $11.2-million to Pratt & Whitney for further development of the J-58 turbojet. and $6.4-million to the firm for advanced J-57 engines for the F8U-2N fighter.

The Navy terminated its $441-million contract with Martin-Baltimore for the P6M Sea Master. Nine of the 24 planes ordered have been delivered. The Department of Defense estimates it will recover about $72-million from the programmed contracts.

ATLAS ABLE IV USED FOR LUNAR ORBIT TRY

Hardware for the U. S. attempt to orbit the moon — struck by a Soviet rocket on Sept. 13—is quite similar to the successful Explorer VI vehicle.

Designated Atlas Able IV, the vehicle of the October lunar attempt has an Atlas first stage booster. Explorer VI had a Thor first stage. Upper stages are the same for both (Aerojet General liquid second stage and Alleghany Ballistic Laboratory solid propellant third stage).

Payload of Atlas Able IV is similar to the "paddle-wheel satellite," except that it includes retro-rockets. These are designed to slow down the lunar vehicle, making it "ripe for the catch" by the moon's gravitational pull.

The U. S. Pioneer IV missed the moon by nine deg. last January and is believed orbiting the sun.

SCOUTING RE-ENTRY

First Scout solid propellant rocket is scheduled to be delivered to NASA's Wallops Island, Va. test station early this month. It could be used to test re-entry conditions. New Scout family aims at low-cost orbits and high altitude probes.

STRUCTURES ENGINEERS

Exceptional opportunities are available for Structures Engineers on our B-70 and F-108 weapon systems and X-15 manned space aircraft.

Stress Analysis—Rigorous design requirements necessitate extensive structural investigation of the influence of high temperatures and unconventional external loadings. Stress engineers concerned with such structures will have the opportunity to utilize their technical knowledge to the fullest extent in the development of new analysis methods.

Load Analysis—Corresponding demands on the structural loads engineer have also created unique careers with significant potential in the fields of dynamic loads, aeroelastic loads, loading spectra, flight load data analysis, and digital and analog computer programming.

Weight Analysis—Exacting air vehicle performance requires the optimization of structural design layouts to produce the lightest weight configurations. Weight engineers with experience in stress analysis are required for the formulation of advanced weight estimation and control procedures.

For details about these positions please write: Mr. L. K. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

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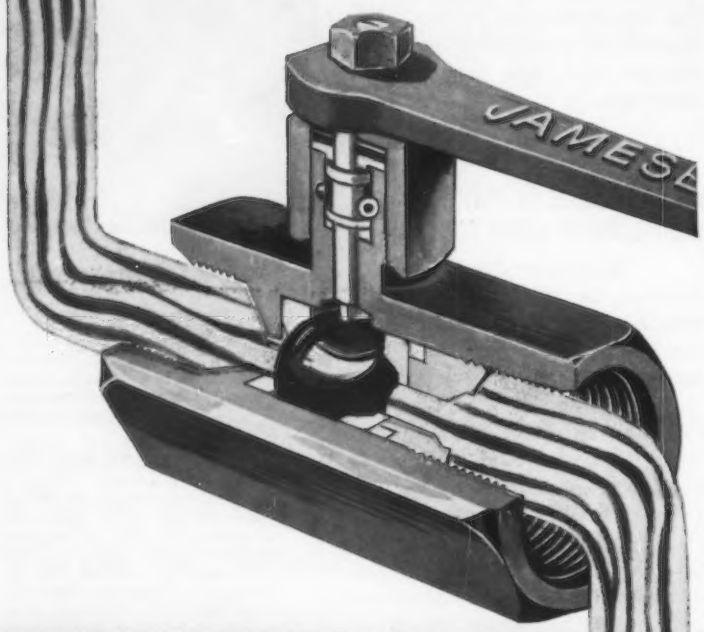
"Double-Seal"™

HIGH-PRESSURE BALL VALVES

STYLE H SERIES

3000 — 4,500 p.s.i. Range



. . . outstanding design newly available to industry

for
- High-Pressure service
- High-Vacuum service
- Handling of hazardous fluids
- Cryogenic operations

. . . no other valve has these outstanding features

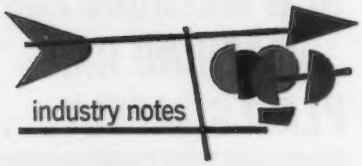
- Unit-body construction
- Positively leakproof
- Full-flow capacity
- Indestructible in service
- Corrosion-resistant
- Contamination-proof
- Incomparable size-rating-test-burst performance ratio

— a newly developed and advanced valve design with broad industrial applications, available in eight sizes — from ¼" through 2" tubing or pipe threads — with 303 and 316 Stainless Steel or Carbon Steel bodies. Choice of nylon or "Teflon" seats and seals.

Distributors in principal cities.
For further information, write: Data: Style "H" Series

225-8

JAMESBURY CORP., 130 NEW STREET, WORCESTER, MASS.



FACILITIES . . .

First Air Force testing site for advanced inertial guidance systems is planned at **Alamogordo, N. M., Missile Development Center.** Some 100 engineers will be assigned there within the next two years; some 350 when it is fully operational in 1963.

Ferranti Ltd. has enlarged facilities for producing a new series of high-precision gyroscopes and accelerometers. Dust-proof building at Crewe Toll, Edinburgh, comprises machine and process shops, assembly and test areas, laboratories and offices.

Boeing Airplane, Seattle, is using three new deep freeze chambers to plunge temperature to 100 deg below zero, for r & d on B-70 wings. Teamed with a hot draw furnace, freezers give temp range from —100 deg to 1,750 deg.

Atlantic Research Corp. has acquired **Prewitt Aircraft Co.,** Clifton, Pa.

Cornell Aeronautical Laboratory will design and build the first wind tunnel for long duration testing of hypersonic under actual atmospheric flight conditions vehicles at its Buffalo research center. In 15 sec. test durations, airflows can approximate 10,000 mph and temperatures of 9,000°F.

Taylor Fibre Co. is operating a new center near Norristown, Pa., for basic research in vulcanized fibre and laminated plastics.

Solar Aircraft will build a $1-million center in San Diego for engineering and research on gas turbine engines, missiles and spacecraft. It has sold its Des Moines, Iowa, installation.

A new laboratory has been established at the **Poulter Laboratories Div., Stanford Research Institute,** for research on new high energy propellants for large rocket engines.

The Union Carbide Research Institute will study physical and chemical behavior of matter in a new building to be completed in 1960 near Tarrytown, N. Y.

TERRA-SCOPE

Air Force representatives in each prime contractor plant will be responsible for reporting failures of equipment furnished by the Air Force to the contractors. This was formerly an Air Materiel Command area responsibility.

•

Centralized testing concept is employed for "wringing out" the Air Force/Convair B-58 Hustler. It abolishes old eight-stage phase testing by manufacturer, uncentralized Air Force test centers and Air Force units. A centralized test force at Carswell AFB works with Convair on its intensive flight testing of all bits and pieces. Same force manages most of the subsequent tests. Elimination of duplication saves several months production time.

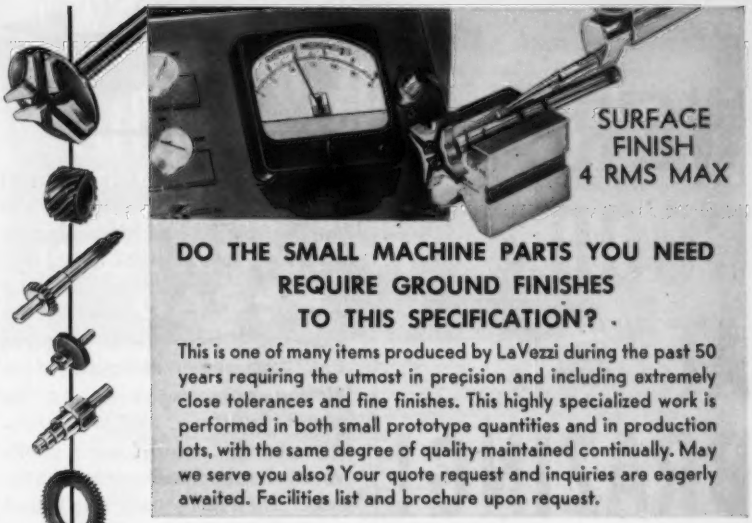
•

Umbaugh-18 rotary-wing VTOL aircraft is scheduled for production at Fairchild Engine and Airplane Corp. in early 1960. Pusher-type propeller, powered by a Lycoming 180 hp piston engine, obtains forward motion. Overhead three-bladed rotor, only connected to the motor for a few moments before vertical take-off, provides lift.

•

A team of engineers, lab technicians, and production experts at Sperry Gyroscope Co. reduced the B-58 Nav Unit harness 40 per cent. Harness is laid out three-dimensionally and built into exact form. Number of wires is cut 30 per cent (to about 4,500) by splicing wires together. Production experts used engineering wire lists and methods running sheets instead of cumbersome drawings. Estimated time-saving: one year.

continued on page 76



DO THE SMALL MACHINE PARTS YOU NEED REQUIRE GROUND FINISHES TO THIS SPECIFICATION?

This is one of many items produced by LaVezzi during the past 50 years requiring the utmost in precision and including extremely close tolerances and fine finishes. This highly specialized work is performed in both small prototype quantities and in production lots, with the same degree of quality maintained continually. May we serve you also? Your quote request and inquiries are eagerly awaited. Facilities list and brochure upon request.

LaVezzi MACHINE WORKS

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American Beauty...an iron for every Soldering Job

Whatever your soldering problem, American Beauty has the right iron for your particular job. The finest engineering, best materials and on-the-job experience since 1894 is yours with EVERY American Beauty. There is a right model, correct tip size (¼" to 1⅛") and proper watt-input (30 to 550 watts) to do any soldering job. Ask about which iron will do your job best. American Beauty electric soldering irons are the highest quality made.

ILLUSTRATED IS CATALOG NO. 3125 ¼" TIP SIZE, 60 WATTS

TEMPERATURE REGULATING STANDS Automatic devices for controlling tip-temperature while iron is at rest—prevent overheating of iron, eliminate frequent retinning of tip, while maintaining any desired temperature. Available with heavy-gauge perforated steel guard—protects user's hand.

YOU CAN'T BEAT A SOLDERED CONNECTION

203-B

WRITE FOR 28-PAGE ILLUSTRATED CATALOG CONTAINING FULL INFORMATION ON OUR COMPLETE LINE OF ELECTRIC SOLDERING IRONS—INCLUDING THEIR USE AND CARE.

AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 2, MICHIGAN

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pardon our brash phrasing

WE'RE GOOD AT BRAZING!

in fact we are

SPECIALISTS

in the use of pure dry hydrogen and nickel alloy for brazing aircraft, rocket and missile components. Our equipment is also ideally suited for bright annealing powdered metal sintering and copper brazing.

let us

SEND YOU

our illustrated brochure "Trail Brazing for the Space Age." Use handy coupon below.

WESTERN ALLOY
ENGINEERING CO., INC.
847 Truck Way, Montebello, California

Please send me, without obligation, the brochure "Trail Brazing for the Space Age."

Company Name_____

By_____

Address_____

City_____ Zone___ State_____

Circle 54 on Inquiry Card

industry notes

Flight and wind tunnel tests of aircraft with paddle spoilers partially replacing ailerons for lateral controls have been conducted at the Langley Research Center. NASA Technical Note D-32 reports that "excessive control-system friction appears to be an inherent fault . . . and will probably prohibit use of such spoilers in nonboosted control systems." Ineffectiveness was found at small deflections.

CLASSIFIED ADVERTISEMENT

DESIGNER, to join our engineering group in designing gimbal type flexible joints incorporating bellows seals for aircraft and missile applications requiring high pressures and temperatures and corrosion resistance in stainless steel. SPLENDID opportunity for capable man with rapidly growing aircraft and missile parts firm highly regarded in the industry. SEND resume stating experience and desired salary. All applications held in confidence. Avica Corporation, P. O. Box 180, Newport, Rhode Island.

COUNTERSINKING
WITH CARBIDE
—Steel, titanium, abrasive non-ferrous materials, including fibre glass panels, heat-treated steels, long runs of any material?

HERE'S HOW YOU SAVE WITH
CRAIG THREADED-SHANK
CARBIDE TIPPED
COUNTERSINKS!

Reverse Spotfacers

Reverse Countersinks

Consider the original cost of carbide cutter, *plus* fewer resharpenings per run, *plus* fewer cutter changeovers, *plus* more burr-free holes...

divided by the total number of parts...

equals the lowest cost per hole—the only cost you care about!

The same profit formula works with Craig Reverse Countersinks and Spotfacers, too! Write for catalog and prices.

CRAIG TOOLS, INC.

133 Lomita Street • El Segundo, California

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ENGINEERS—SCIENTISTS

Seek and Find Daring New Goals and Rewards with General Electric's Growing

FLIGHT PROPULSON DIVISION IN CINCINNATI

Our engineers and scientists enjoy the daily challenge of new and stimulating technical problems in the largest number of advanced propulsion system projects in our history. Men with imagination and ideas are needed as Managers and Specialists in:

. . . . high Mach powerplants using hydrocarbon fuels (Jet Engine Dept.)

. . . . commercial jet powerplants (Commercial Engine Operation)

. . . . plasma and ion power sources for rockets and space vehicles; VTOL powerplants. (Flight Propulsion Laboratory Dept.)

. . . . developing production techniques for unusual materials and design configurations (Production Engine Dept.)

Advancement opportunities are multiplied—

nearly 50% of our professional people earn promotion every year. Our engineering staff has more than doubled since 1955.

● ***LOOK INTO NEW POSITIONS NOW OPEN IN OUR 4 DEPARTMENTS IN CINCINNATI FOR Engineers and Scientists experienced in:***

MECHANICAL DESIGN
Jet, rocket powerplants
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RELIABILITY ENGINEERING
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QUALITY CONTROL
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METALLURGICAL ENGINEERING

For further information on the opportunities that will let you use your talents better, send your resume to Dr. Mark Elwood, Bldg. 100, Dept. 125-MJ

FLIGHT PROPULSION DIVISION

GENERAL ELECTRIC

Cincinnati 15, Ohio

Circle 56 on Inquiry Card

Viewing device for high speed aircraft is being designed by J. W. Fecker Inc., Pittsburg, for the Air Materiel Command. Somewhat similar to a flight periscope, it is reportedly the first of its type to fall within military weight and dimensional requirements. Aimed at eliminating heating and thermal shock problems of windshields and canopies, it includes a rapid closure system shielding pilot's vision against light flashes.

•

Air-cushion vehicle manufactured by National Research Associates, College Park, Md. for the Marine Corps is now ready for delivery.

•

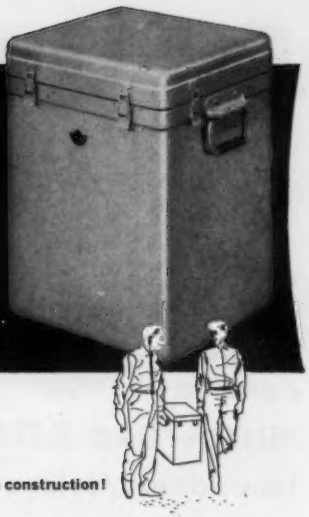
Available from the National Machine Tool Builders' Asso.—a 16 mm, 27½ minute film explaining the job of machine tools and contrasting primitive and modern production. Title: "One Hoe for Kalabo."

NOW for the first time!

KING SIZE

AMAZING NEW SUBMERSIBLE

Standard Aluminum INSTRUMENT CASES



Only TA offers you:

★ New extra-deep, submersible design!
★ Choice of 120 basic types and sizes!
★ Tailored cases at off-the-shelf prices!
★ Special shock-mounted reinforced aluminum construction!
★ 4-week delivery on prototypes!

TA's new King-Size line includes cases up to 30" high—yet prices are comparable to those of standard-depth containers.

You simply choose from the many standard lid sizes, specify the depth and accessories (latches, handles, pressure relief valves, etc.) and TA does the rest. In fact TA even furnishes you free vellums and templates so you can design your instruments to these standard sizes and save yourself costly tooling charges.

Write for TA Engineering Manual 402G. Free—(no obligation). Get the TA King-Size story today.

TA Mfg. Corp. 4607 Alger Street • Los Angeles 39, Calif.
(or call CH 5-3748)
TWX 9863 Glendale, Calif. • WUX CAT Los Angeles, Calif.

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to keep hydraulic valves free and functioning properly . . . use

FERROFILTER®

MAGNETIC SEPARATORS

Frantz FERROFILTER Magnetic Separators protect fluid power systems of aircraft, missiles and ground support equipment by removing even microscopic ferrous particles which may pass freely through edge-type strainers and even escape conventional cartridge type filters.

FERROFILTERS help prevent sticking and nonfunctioning of finely fitted valves, pistons and other precision-made components.

Model PX-2 High Pressure

3000 psi working pressure . . . 12 gpm flow capacity . . . 3 lbs dry weight . . . ¾ - 16NF - 3 thread for ½" tube connection, Spec. AND-10050 . . . Size 5-⅜" long, 2¾" dia. Model PX-1 for 6 gpm, ⅜" tube.

Model P2H-50 High Pressure

5000 psi working pressure . . . 12 gpm flow capacity . . . 15 lbs dry weight . . . for ¾" taper pipe, NPTF; also ¾" tube connection, Spec. AND-10050. Others rated at 2000 psi; Capacities up to 40 gpm.

Write for Bulletin PM-37 and other literature

S. G. FRANTZ CO., Inc.
Brunswick Pike & Kline Ave.
P. O. Box 1138 Trenton 6, N. J.

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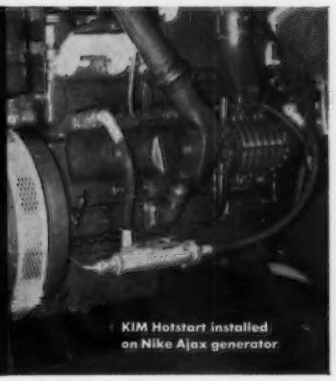
KIM HOTSTARTS keep U.S. NIKE AJAX on all-weather ALERT!



KIM Hotstart installed on Nike Ajax generator

When efficiency is measured in split seconds, "cold starts" must be eliminated. That's why Nike Ajax are now equipped with KIM Hotstart engine pre-heaters. Regardless of weather, they enable operation under full load within seconds. For details on KIM Hotstarts, see your automotive dealer or write us for free literature.

KIM Hotstart

KIM HOTSTART MANUFACTURING CO.
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Now! get complete data on

MINIATURE AGASTAT®
time/delay/relays

This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1½", with adjustable timing ranges starting at .030 and as high as 120 seconds.

The folder gives operating and environmental specs, coil data, contact capacities, dimensions, diagrams of contact and wiring arrangements. *Write:* Dept. A33-1022.

AGA DIVISION — ELASTIC STOP NUT CORPORATION OF AMERICA
Elizabeth, New Jersey
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For torqueing problems USE the

New "TITANTORKER" controlled TORQUE DRIVER

"TITANTORKER" makes controlled power torque available for a variety of torque uses — at low cost.

When desired torque is reached an audible signal is given as the internal driving balls are forced out of their sockets and overrun.

EASY ADJUSTMENT — For increased or decreased torque, "TITANTORKER" can be simply adjusted with an Allen wrench.

"TITANTORKER" can be used with any motive power except impact wrenches. Is ideal for most controlled power torque problems due to ease of adjustment and maintenance.

Available in 4 sizes in maximum torques from 75" lb. to 225' lb., with Female Adapters in driving head and Male Adapters on torque base.

Write for details and prices

TITAN TOOLS — World's Largest Producers Of Stud Drivers And Pullers
TITAN TOOL CO.
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What about

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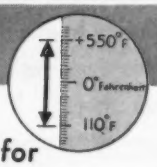

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readers' orbit

Teflon . . . Some Divergent Views

. . . In the Status Report on Flexible Hose by E. M. Ramberg, July, 1959, the following statement appears: "'Teflon' is limited . . . to 450°F. Above 450°F it begins to decompose and gives off fluorine gas."

This statement embodies the misconception that hose of "Teflon" TFE-fluorocarbon resins is limited in upper service temperature by decomposition, which is not correct. At 450°F the rate of decomposition is minute (less than 0.0002 per cent/-hr.), and simple calculations show a large safety factor in most applications. The ability of TFE resins to sustain mechanical flexing at high temperatures is often the limiting factor but it should be noted that TFE resins are frequently employed in hose applications at 500°F. Also it should be noted that fluorine gas has not ever been detected amongst the decomposition products of "Teflon" TFE resins. This experimental finding is as would be expected from theoretical considerations as the decomposition of TFE resins to fluorine is not favored thermodynamically . . . comments are offered to avoid misinterpretations of an otherwise excellent article.

G. R. Snelling,
applications technologist
E. I. DuPont

Evidence seems heavily weighted against Application Technologist Snelling's contention that Teflon is not limited in upper service temperature by decomposition. In each of the Technical Information Bulletins du Pont issues for the various Teflon formulations, this statement appears, . . . "above 400°F small quantities of gaseous decomposition products are evolved from TEFLON (TFE) resins. Some of these gases are harmful . . . ." Rate of decomposition is slow at 400°F, as stated, but increases to 0.09 per cent/hr at 788°F. . . . Hose designer Ramberg's opinion on products of decomposition agree with hose user Chuck Daniels opinion at Rocketdyne Div. of NAA. ". . . we're probably good up to 450 (°F) with Teflon, but when we exceed 500 (°F) we get cold flow characteristics . . . above that we give off fluorine gas. . . ."

Objects to Proposed Spec

. . . We are calling attention to some of the unreasonable requirements of a proposed specification now out for comment from industry . . . [MIL-I-25135C (ASG)]. It allows use of . . . possibly toxic penetrant materials, with no limit on deleterious impurities such as sulfur and chlorine . . . it requires that all penetrant materials be used only in artificial "family groups" . . . all members of the "family" must be from the same manufacturer, and must not be used or mixed with the same material from another manufacturer.

This would require . . . repurchase (of) the same brand of all materials in the "family," regardless of price, unless all materials on hand are discarded. . . . (This specification) . . . promotes monopoly.

L. W. Sockman,
president
The Met-L-Chek Co.

Conversion Problems

. . . An item regarding a new type of phosphinoborine molecule . . . appeared in the July issue of A&M (materials and components) . . . would like to voint out an error that could lead to some confusion . . . (we) stated (that) American Potash & Chemical Corp. hopes to develop . . . "plastics that can withstand temperatures up to 400 deg Centigrade or, roughly, 750 deg Fahrenheit." Somehow this appeared in the magazine as "750°C," which would be about 1350°F . . . we'd be grateful if a correction could be made.

Donald B. Reeve,
Hill and Knowlton, Inc.

Reader Reeve has conversion problems too. 750°C is hotter than 1350°F . . . 1382°F would be more correct.

XLR-99 . . . Not a Converted Missile Engine

. . . "Rockets For Manned Flight" . . . (August 1959) . . . has been read with a great deal of interest among the engineering staff of our organization. . . . We . . . call attention to the last sentence in the first paragraph . . . in which reference is made to the X-15 powerplant. . . . Our engineers agree with the basic statement that converting large missile engines for manned flight is not a logical approach . . . however . . . many have interpreted the sentence to imply that the present X-15 engine is a converted missile engine. A further implication would be . . . that the engine is unsatisfactory.

Early in the development work (on this engine) we abandoned the concept of converting a missile engine. . . . In other words, the present powerplant . . . has been built from the ground up, and consequently is not a converted missile engine.

Richard F. Whitcomb,
ass't. to general mgr.
Reaction Motors

Exact statement was . . . "experience has already shown, in the development of X-15 powerplant, that converting large missile engines for manned-flight is not a logical approach." It was meant exactly as reader Whitcomb has explained it, not as some have interpreted it. See "X-15—the engine," A&M, June, 1959, for details on RM's XLR-99.

One Slight Typo

. . . On reading the article, "How to Machine These HT Alloys," (May 1959) I found one slight typographical error . . . so slight that I would hesitate to write if it were not possible that someone might be confused at a later date. The "J-1630" alloy should be "J-1650" . . . to my knowledge there is no such alloy as J-1630.

H. M. Schrier,
design engineer
General Electric Co.

your date book

october 5-7
anglo-american aeronautics conference
institute of the areonautical sciences
hotel astor, n. y.

◆

october 5-7
national communications symposium
institute of radio engineers
hotel utica, utica, n. y.

◆

october 5-9
national aeronautic meeting
society of automotive engineers
ambassador hotel, los angeles

◆

october 6-9
international symposium on high-temperature technology
stanford research institute
asilomar conference grounds, monterey peninsula, calif.

october 7-8
advanced propulsion systems symposium
OSR (air force), Avco

◆

october 7-9
national symposium on vacuum technology
american vacuum society
sheraton hotel, phila., pa.

◆

october 8
forty-first annual meeting
american ordnance assn.
aberdeen proving ground, md.

◆

october 8-10
semi-annual meeting
american society of tool engineers
chase-park plaza hotel, st. louis

october 8-10
symposium on pilot's role in space exploration
society of experimental test pilots
beverly hilton hotel, beverly hills, calif.

◆

october 11-16
pacific area national meeting
american society for testing materials
sheraton palace, san francisco

◆

october 12-14
national electronics conference
hotel sherman, chicago

◆

october 13-15
technical meeting
chicago asso. of spring manufacturers
graemere hotel, chicago

◆

october 14-23
world-wide interceptor weapons meet
air defense command
tyndall afb, panama city, fla.

◆

october 17-25
outer space show
107th regiment armory, n.y.c.

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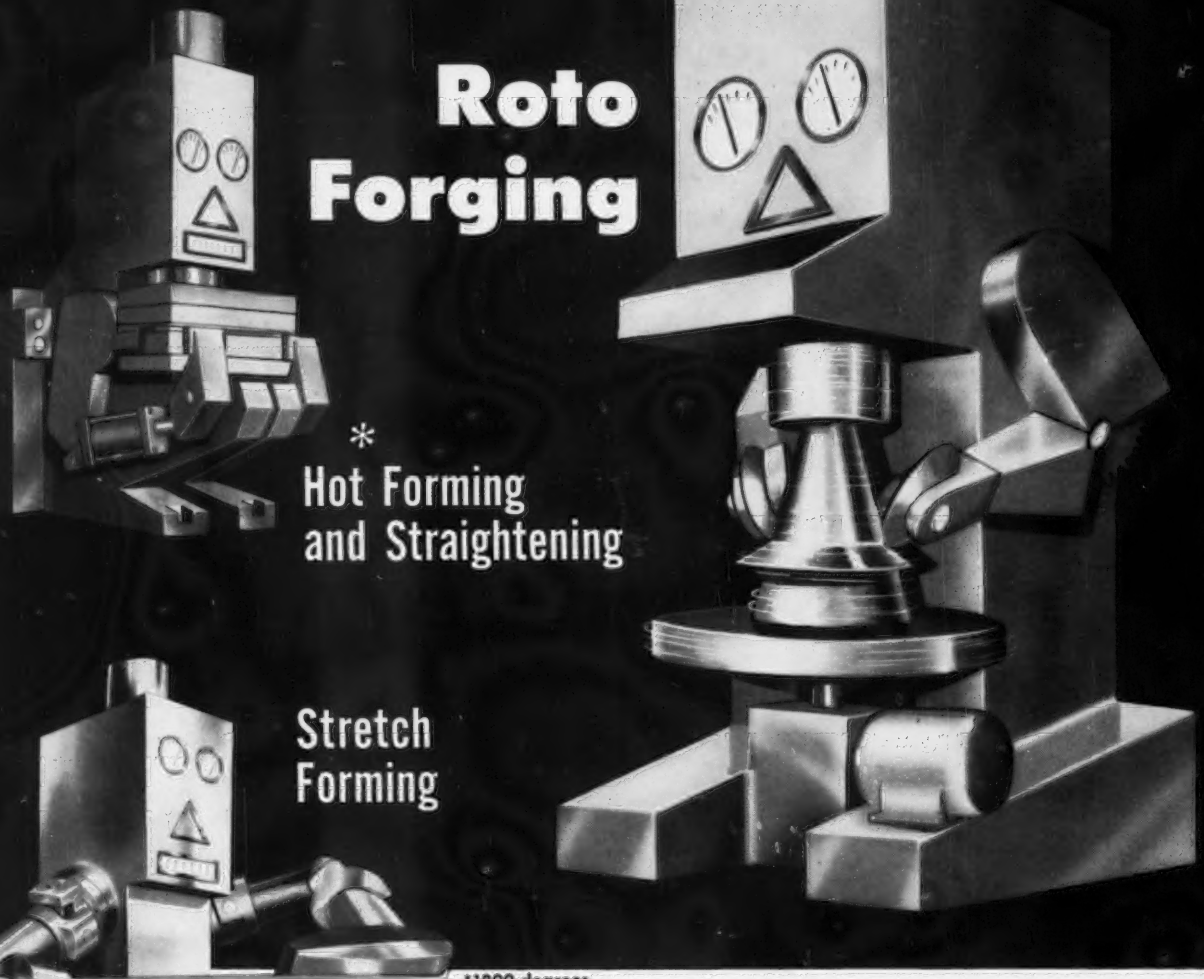

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